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THE WATER AND ELECTRIC POWER PLANT OF THE UTAH SUGAR COMPANY.

By W. P. Hardesty, C. E.*

Among the states of the arid west that were first developed by people of English-speaking origin, Utah was the pioneer in the practice of irrigation, and the use of the waters of the state for this purpose has always had precedence in right and in importance over other economic uses. The extensive development of water-powers during the past eight or nine years, caused by the great advances made in the generation and transmission of electrical power, has resulted in the use of water for power in this state becoming more or less closely related to its use for irrigation.

GENERAL DESCRIPTION. — Nearly every power plant heretofore constructed has been in or near the mouth of a canon issuing from the mountains, so that the water is returned to its natural channel above where diverted for irrigation. In the water-power development to be described, however, the supply canals were built entirely for irrigation, and the needs of such must be supplied before any water is available for power purposes. By taking advantage of the fact that during all but about two months of the late summer and fall there is water going to waste, and by the existence of an excellent natural site along the canals for the creation of a power plant, very beneficial use is made for power as well as for irrigation.

VIEW OF POWER PLANT FROM WEST SIDE OF BEAR RIVER.

In the northern part of the state the Bear River, after a long and devious course through parts of Utah, Wyoming and Idaho, passes from the broad Cache Valley, through a narrow gap in a range of mountains, into the Bear River Valley of Box Elder County. The fall of the river through this rocky gorge, known as Bear River Canon, is quite rapid, while the current is sluggish both above and below. To secure the elevation necessary to cover the bench lands of Bear River Valley, it is necessary to divert the water at the head of the canon. This was done by the Bear Lake and River Water-Works & Irrigation Co. in 1889-91. In Engineering News of Feb. 6 and Feb. 13, 1896, there is given a very complete description of all parts of this system as it then existed, including the dam and head-works, and the canals in the canon.

*228 Commercial Club Building, Salt Lake City, Utah.

These properties, after many vicissitudes, have, within the past three or four years, passed into the hands of the Utah Sugar Co., and the development of the system has progressed very fast. Much work has been done in rebuilding and rendering more safe the canals through the canon. The country here is probably the most difficult through which it has ever been undertaken to build large canals. Though irrigation water conveyors have been built through canons as rugged, resort has been had to tunnels, pipes or flumes. The former, on account of expense, and the latter by reason of their perishable nature, are objectionable, so that in this canon an open canal is used for much the greater part of the length. There are two canals, one on each side of the river.

The mouth of the canon proper is reached in about two miles by the canals. Below here the canals have to pass for several miles along the steep clay slopes of the narrow valley before finally reaching the top of the bench. Up to this point construction and maintenance are most difficult; beyond it all is easy sailing.

The natural fall in the river from the dam to the mouth of the canon is about 110 ft. The water level is raised by the former, so that the actual static head from the surface of water in the canals to a point above medium water in the river at the mouth of the canon is about 115 ft. The fall of the canals through the canon is 3.62 ft. per mile.

During all the year outside of the irrigation season, and also during the earlier part of the latter, there is plenty of water in the river for the development of power. There is an excellent site at the mouth of the canon for a power plant, and as the water-conveyors for carrying water along the sides of the canon at the greatest available elevation were already in existence, the company decided to construct such a plant.

The plant is 45 miles north of Ogden, on the line of the Oregon Short Line R. R., and is four or five miles north of the town of Collinston. As first constructed, in 1903, the power-house provided for only two units of development, but during the latter part of 1904 an extension was built to accommodate a third unit.

At the site selected, where the canon opens out into a narrow valley, the two canals (called the East Canal and the West Canal) are about 1,000 ft. apart. The power-house is located on the east bank of the river. As it is desired to draw water from either canal, a pipe is run directly across the valley, connecting the two canals. Water can be drawn from one or both of the canals, or the pipe can be used to pass water from one of the canals over to the other, independently of the plant. From the bottom of this pipe, in profile like an inverted siphon, the feed pipes to the power-house lead off. This layout is clearly shown by Fig. 1, and the view on this page.

PENSTOCK SIPHON. —The siphon itself is noteworthy. It is of California redwood, 8 ft. inside diameter, and 935 ft. in length. The level portion at the bottom (418 ft. long) has its center 96 ft. below the bottom of the West Canal, and about 93 ft. under the bottom of the East Canal. Beginning at the West Canal, the pipe runs down the slope, with grade line at an angle of 29° with the horizontal, to the river bank, and is carried across the river on a three-span steel truss bridge, on by the power-house and up the east slope on an angle of 17°, to the East Canal. There is 195 ft. of pipe on the west slope, and 322 ft. on the east one. The bridge spans are each 75 ft., and they rest on concrete piers and abutments, founded on bedrock, which is reached in 2 or 3 ft. in the middle of the river. The west abutment, and the support or anchorage for the elbow at foot of the pipe on the west slope, were made together as a single concrete structure.

The pipe staves are from 4 × 6 stock of clear California redwood, milled to 3½ ins. thick by 6

ins. on the outside of curve. They were run a little larger than necessary in order that the pipe would cinch down to the correct size when the bands were tightened. The latter are of ¾-in. round mild steel. Each band is in two halves or sections, one section with threads at each end and the other with heads at each end. Two shoes are thus needed for each band, and they are of malleable iron. The bands were spaced sufficiently close to withstand the strains, due both to the water-pressure and the swelling of the wood, with a factor of safety of 4. In such a large pipe the strains due to the swelling is an important factor.

At the connection of each of the inclined sections with the horizontal part of the pipe there is placed an elbow, Fig. 2, to make the required turn. Each elbow is of ⅜-in. steel plate, 8 ft. inside diam., and having a net length of 10 ft. The joint at each end is made by forming a bell at the end of the steel pipe. This consists of two steel angle bars encircling the pipe, riveted to each other and to a steel band. The end of the wood pipe is inserted in this, and the space thoroughly calked with lead. The joint is about 8 ins. long over all, as shown by Fig. 3.

As before stated the concrete support for the west elbow is in one with the bridge abutment. The east elbow rests on a very large block of concrete founded on the gravel formation. The elbows are well bedded in these supports. The inclined portions of the pipe were laid on the natural soil and then covered over. The horizontal portion is supported by the bridge and by a low trestle leading out to the east elbow. This portion has been covered over with a wooden sheathing for protection against the weather. The part on the trestle is supported by saddles or cradles, made of 8 × 10-in. redwood, and spaced about 4 ft. apart. These afford a bearing for about one-third of the circumference of the pipe. On the bridge the saddles are made up of steel plate and angles, and are spaced 6 ft. apart. The wooden stave pipe was built by the Excelsior Wooden Pipe Co., of San Francisco, Cal.

INLETS TO PENSTOCK.—The ends of the siphon are connected with either canal by a concrete turnout or inlet. The inlet has curved sides that converge to the mouth of the pipe, to give an easy entry to the water and avoid eddies. A gate, in front of which is a screen, is used for regulating admission of the water to the pipe. The view Fig. 4 shows one of these inlets. The inlet virtually forms the stem of a T, of which a concreted section of the canal forms the main line. In this section are placed two gates, one above and one below the turnout.

By this arrangement most complete control is had of the water for both the power plant and the irrigation system. In case of a break in either canal between its head and the plant (which is liable to occur), the water for both can be carried through the other one, down to the siphon, then through it, and delivered to the damaged canal below the break. Water can also be shut off from passing any further. This use of the siphon as an adjunct of the irrigation systems interferes none with the draft on it for power purposes. This arrangement cost about $30,000 more than would have one that provided supply from only one of the canals (the East Canal). In the latter case, two lines of 66-in. pipe leading down to the power-house would have answered. The water supply to the plant would not have been reliable, however, besides which, by the adopted plan, a portion of the cost is chargeable to the irrigation system, on account of its increased security and convenience.

The construction of the East Canal was not completed until the year 1903, it having lain in a partially finished state since the first work 14 years before. It has been put in use for irrigation purposes, but has not the importance of the West Canal for this use. On account of frequent breaks in the canon portion, during 1904 the East Canal was deepened from the dam to the power-house by about 2 ft., and many new masonry walls were built to replace weak portions in the lower bank. It has a waste-gate about 1,000 ft. above the siphon, and just below there is also one that discharges through a long flume into the river.

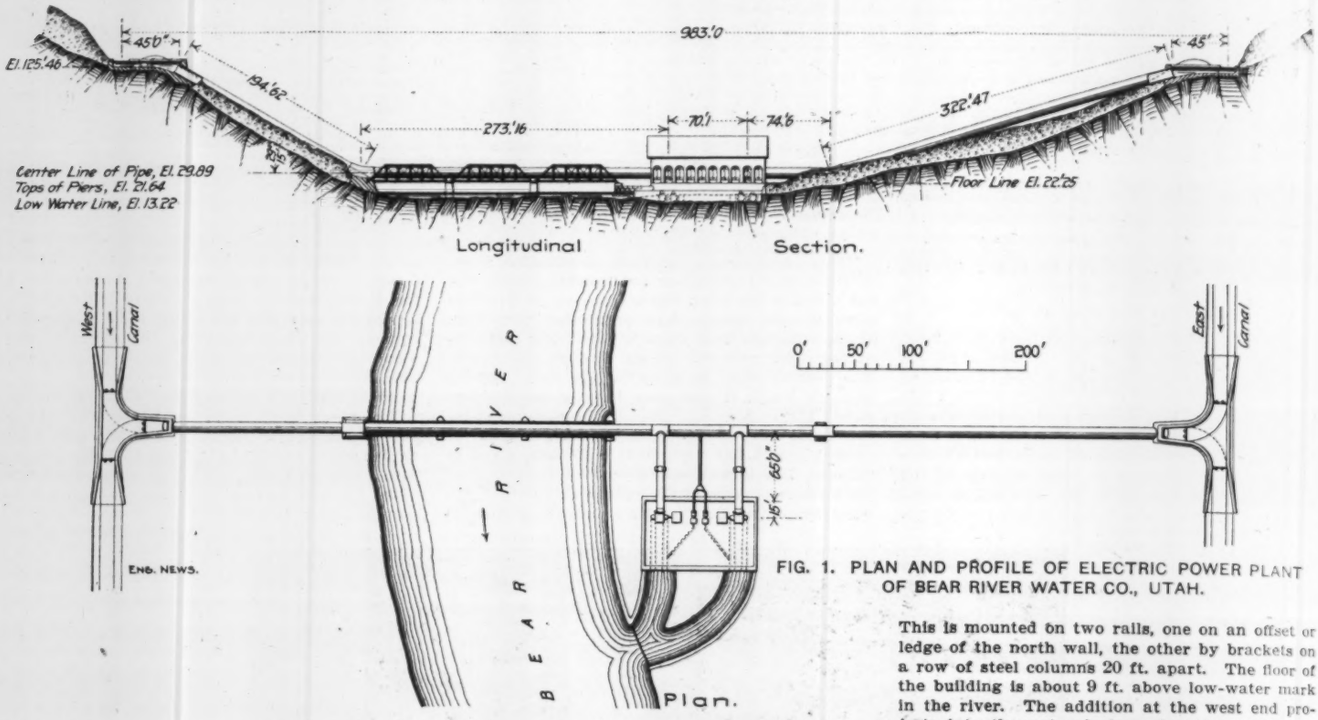

FIG. 1. PLAN AND PROFILE OF ELECTRIC POWER PLANT OF BEAR RIVER WATER CO., UTAH.

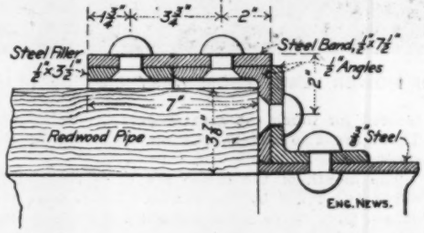

Fig. 3. Detail of Joint Between Wood Stave Pipe and Steel Elbow.

POWER-HOUSE.—The power-house is [illegible] on the east bank of the river. As first [illegible] was 60 × 100 ft., but during 1904 an addition of 36½ × 38½ ft. inside was made to the west end. The building is of brick 60 × 136½ ft. inside and has concrete foundations carried down to rock, which latter is found at a few feet [illegible]. Traveling the full length of the building and covering 40 ft. of its width, is a 20-ton crane. This is mounted on two rails, one on an offset or ledge of the north wall, the other by brackets on a row of steel columns 20 ft. apart. The floor of the building is about 9 ft. above low-water mark in the river. The addition at the west end projects into the natural channel, which had to be slightly deviated. The floor is 4 to 5 ft. above extreme high water mark.

Inserted in the main wooden pipe (siphon) are three 15-ft. sections of steel pipe, Fig. 2. The two east-most ones (belonging to the original building) are 70 ft. apart, while the west one is only 23¼ ft. from the adjoining one. These sections are of ⅜-in. steel plate, double-riveted. Leading from each section to the power-house (65 ft. distant) is a 66-in. steel penstock. These pass through the north wall to the turbines. The three turbines are each double-discharge Leffel wheels, having runners 34 ins. in diameter. Just inside the power-house, on each pipe, is a 66-in. valve, weighing 17 tons. The cost of each was $5,000. The valves are operated by belts from a shaft driven by a small motor. The turbines are equipped with Lombard governors, and also with levers for hand-regulation. Each turbine will develop 1,400 HP. when supplied with 140 sec. ft. of water, with 80% efficiency. Ordinarily only 1,000 HP. is developed. Each wheel is direct-connected to a 750-KW. Westinghouse generator of the revolving field type. A three-phase alternating current is generated at a voltage of 2,300. The exciter generators are separately driven by small turbines, water for which is brought in a 24-in. pipe direct from the 8-ft. pipe. They thus secure much better regulation by being independent of the main units.

The water from each turbine is discharged through its two draft tubes, each leading by a long vertical bend to a flaring concrete tunnel. These are under the floor, and they empty into an open tail race on the south side of the building. With the surface of water in the tail race at an ordinary stage, and 5 ft. of water in the West Canal, there is secured a static head of 115 ft. The surface in the tail race is about 10 ft. below the center of the wheels, which are 4.3 ft. below the center of the 8 ft. pipe.

Near the center of the building is located the switchboard. This has 12 marble panels, on which are mounted the necessary indicating and

recording instruments. As first constructed, the oil switches were attached to the back of this. As these proved to be dangerous to a certain extent and otherwise objectionable, when the plant was enlarged a different plan was adopted. About 5 ft. back (towards the south wall) a brick wall was built, and the switches were placed back of this. They are operated by lever connections extending under the floor from the switchboard. The current from the generators is carried by the three wires in a 2-in. lead pipe (with rubber insulation) under the floor and up through the wall to the switches. All low-tension wires and cables in the building are carried under the concrete floor in clay conduits. From the switches, the 2,300-volt current is carried to the transformers. There are three sets of these, each opposite a turbine and about on line with the switchboard. Each set contains three oil-insulated transformers by which the voltage is raised from 2,300 to 40,000. The six transformers first put in are square, and are cooled only by the air. The three for the addition are cylindrical, and they are water-cooled.

FIG. 2. VIEW SHOWING STEEL ELBOW ON SUPPORT IN WOOD STAVE PENSTOCK SIPHON.

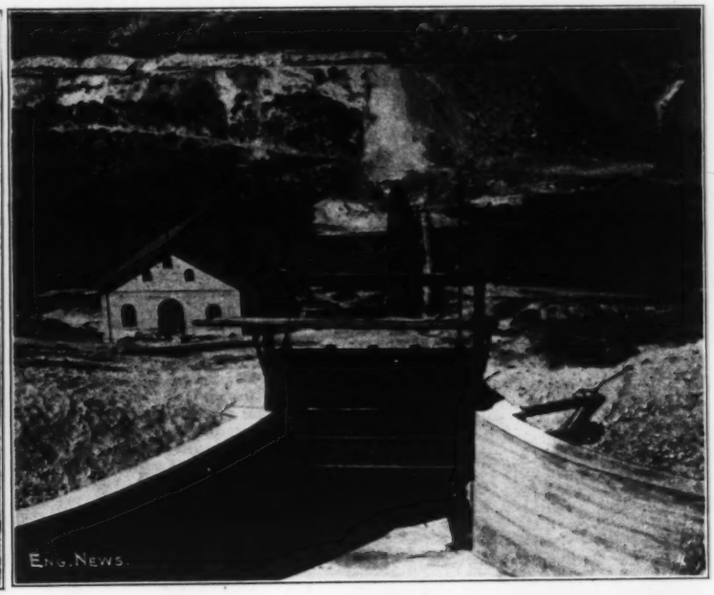

FIG. 4. VIEW OF INLET FROM CANAL TO PENSTOCK SIPHON.

On leaving the transformers, each wire of the 3-phase circuit passes successively to a static interrupter, a high-tension switch, a low-equivalent lightning-arrester, and finally out of a window through a long glass bushing. The latter is supported only by the two heavy plate-glass sheets, spaced 6 ins. apart, with holes in the center for the bushing.

TRANSMISSION LINE.—From the power-house the three-wire transmission passes up the east slope of the canon to the top of the bench or mesa, just across the railroad. It then runs southerly, keeping along the base of the mountains and mostly above the settled portion of the localities it traverses. At Ogden (45 miles) it taps into the line of the Utah Light & Railway Co., as this company uses all of the current.

The line to Ogden consists of three No. 0 soft copper wires. It is carried on 40-ft. cedar poles, planted 6 ft. in the ground. The poles are spaced 120 ft. apart. The insulators are mounted on two cross-arms. The lower one is 7 ft. long, placed 6 ft. below the top, and it carries an insulator at each end. The arm is braced on either side by an iron piece 1¼ × ⅜ ins. × 2½ ft. long, fastened to the arm and the pole by lag screws. The top arm is only 4 ft. long, and it needs no braces. It is placed 9 ins. below the top of the pole. Both arms are 3¾ × 5¾ ins. in cross-section. The top arm has but one insulator. It is mounted 18 ins. from the center of the pole, and it is reversed from one side of the pole to the other on successive poles. This transposition prevents induction, and are of brown porcelain, 10 ins. high, 11 ins. in diam., and weigh 16 pounds each. They were individually tested at the factory with a 120,000-volt pressure before acceptance. The lower and middle shells were cemented together in the factory, and the top shell cemented on in the field. The insulators are mounted on cast-iron pins, which project 10 ins. above the arm, being threaded at the top to receive the insulator. The pin is bolted to the arm by means of a ⅝-in. steel bolt, which projects below, being screwed into the shank of the pin, and it is threaded to receive a nut for bolting the pin to the arm. To prevent any tendency to split, a 3 × 4 × ⅛-in. plate is bolted to the arm on each side opposite the pin.

Nine feet below the main cross-arm is a smaller cross-arm that carries an iron wire telephone circuit. The line is transposed every one-half mile. Telephones are placed along the line at intervals for the convenience of men patrolling it. They are placed in insulated booths.

The plant and line were built by the Utah Sugar Co., but they are operated by the Utah Light & Railway Co. The ordinary output of 3,000 HP. is sold to the latter company for a term of years. The contract provides that the current need not be furnished during the three months of the busiest irrigation season, when the river runs low and there may be a scarcity for irrigation. This plan is rendered unobjectionable by reason of the fact that the plant is inter-connected with five other stations of the Utah Light & Railway Co., two of which are steam plants. The shut-down occurs, also, during a season when the lighting load is not so great. The latter company owns and operates the large plant in Ogden Canon (built by the Pioneer Electric Power Co.) and two large plants in Big Cottonwood Canon, near Salt Lake City. In the city it also has two steam plants. The distance by the line from Bear River Canon to the city is 82 miles, but the line is tapped into the system at Ogden. A large proportion of the electric power developed by the Telluride Power Co., at its two plants in Provo and Logan Canons, is also supplied to the system. These work in unison with the others, so that there are six water-power and two steam plants that are all operated in parallel through the low-tension side. Though the stations at the extreme ends are nearly 150 miles apart, the dynamos work in perfect synchronism.

The connections with the canals and also the power-house were built under the superintendence of Mr. J. C. Wheelon, Engineer and Superintendent of the canal system. The entire plant and the transmission line were designed and their construction supervised by Hayward & Gray, consulting electrical engineers, of Salt Lake City. The addition in 1904 was designed by Mr. O. H. Gray, successor to the firm, to whom the writer is indebted for the data for this description.

A PRACTICAL METHOD OF ADJUSTING A MODERN GUN AND DETERMINING ITS ERRORS AND THE ERRORS OF ITS TELESCOPIC SIGHT.

By Otto Von Geldern,* M. Am. Soc. C. E.

Indirect firing in modern gunnery involves the determination of azimuth and range from the gun to the target, in which the gun and its accessories become the instrument with which the angles are laid off that place it in correct alinement and elevation, so that its projectile may hit the target.

In a certain sense a gun may be compared to an engineer's theodolite. The gun proper becomes the telescope, mounted with its trunnions in standards held by the carriage resting upon the chassis. The racer or frame that holds the structure is analogous to the upper plate of a transit. It turns with its lower flange upon conical-shaped rollers, that travel upon an upturned face, the so-called roller path, which is a part of a rigid steel frame, called the base ring, that forms the foundation for the whole and which may be compared to the lower plate of an engineer's transit, upon or within which the upper plate, holding the telescope and its mount, may be revolved.

The comparison is more particularly applicable to a barbette gun but the analogy is equally pertinent in the case of the disappearing gun or the mortar.

The brass ring, diameter 10 to 12 ft., graduated to degrees attached to the solid work encircling the racer, forms the fixed azimuth circle. To the racer is fastened a small brass plate or index, which travels with it, gliding along and over the graduated band. This index, spanning an even degree, is divided into twenty equal parts, admitting of a direct reading to .05°, or 3′. As this space corresponds to about 1-16-in., one may easily estimate between the divisions to one-half of this value. The index is not a vernier but a simple spacer.

The elevation or depression of the gun may be read to a fraction of a minute by a mechanical device attached either directly to the trunnion or to some other convenient part of the mounting where it may be controlled by the vertical motion of the gun proper.

It is the purpose of this paper to treat the gun in the sense of a mathematical instrument only, and to explain

*89 Flood Building, San Francisco.

a method by which it may be oriented and adjusted, and by which any error in its horizontal or vertical motion may readily be detected and recorded. The method has been applied with equal success to guns of varying calibers from a 12-in. to a 5-in. bore, as well as to the short and chunky 12-in. mortar.

For the sake of illustration in this discussion, however, the 12-in. breech-loading rifle will be referred to, which has a total length of 40 ft., and fires a 1,000-lb. projectile.

The weight of the mass to be turned around its vertical axis is considerable, and may be roughly placed at:

Weight of the rifle	57½	tons.
Mounted on barbette carriage:		
Weight of top carriage	8	tons.
Chassis and racer	23½	tons.
Platform, cranes, etc.	7	tons.
Total	96	tons.

In the case of a disappearing mount without its counterweight this mass may be augmented by from 15 to 20 tons.

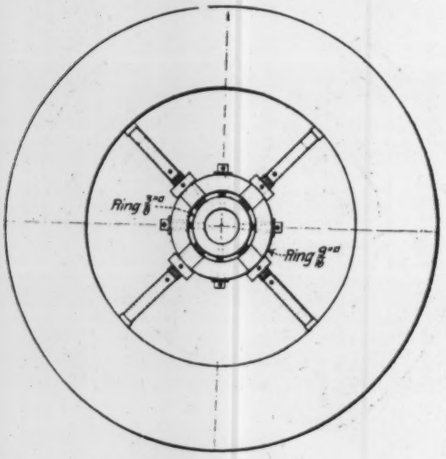

Fig. 1. Bore Sight.

It may be stated at the outset that this cumbersome mass of metal, aggregating about 100 tons, may be moved, that is, turned about its axis, not only with easy facility but also with very great accuracy, for the reason that all its various parts are fitted with a degree of refinement that appears perfectly astonishing; and when a gun is mounted and ready for adjustment it deserves all the consideration that one would give to the test of a transit or a theodolite. This may sound like a remarkable statement, and one scarcely to be credited until personal contact with this sort of machinery has made its lasting impression upon one.

After the erection of the substructure and carriage, the gun is mounted and it is then ready for orientation. The assembled parts of the huge mechanism are so true in their contact and bearings that the gun does not require any direct mechanical adjustment. It is necessary only to ascertain the errors of its readings, and these are principally due to errors of graduation of its huge arcs.

The graduated azimuth circle—the large brass band already referred to—must be marked with figures that are stamped on each degree line in such a manner that the index shall indicate the true bearing of the gun from breech to muzzle. The index plate may be fastened to any convenient part of the racer, and the starting point of the nomenclature of the azimuth circle will necessarily depend upon the position of the index in reference to the circle. The index plate is held in place by two brass screws run through a long slot in the plate; this admits of shifting the index about half a degree in either direction.

The vertical index is set to zero while the gun is in a horizontal position as indicated by means of a sensitive spirit level, such as is ordinarily used in fine mechanical work.

In the horizontal orientation it is made requisite that when the gun points due south the index must be made to read zero or 360°, and that the azimuth band must be numbered consecutively from this starting point in a direction with the clock.

It is evident that if we knew the true azimuth from the gun to a distant object and pointed the gun to it, the index might be adjusted to indicate this azimuth with great accuracy. And having obtained the proper figure for a line of the graduation it is a simple matter to stamp all the others upon the band in numerical order.

This method of working from the gun to distant objects is the one laid down in the Drill Regulations. These instruct the artillery officers to:

> Select and establish a line to be used as the standard base of the survey and harbor chart. Measure its length and determine its azimuth. Verify the work, and mark the extremities of the base and such intermediate points as may be found useful, permanently on the ground. Locate the pintles of the guns and other important points with reference to the standard base. Calculate the azimuths of the direction from the pintles of the different guns to some one or more conveniently located points in the common field of fire. Train the guns on one of these points; set the verniers to read the calculated azimuths of direction, and, after having verified on some other point whose azimuth from the gun pintles is known, mark permanently the numbers on the graduation of the azimuth circles to read the calculated azimuths of directions.

It is advisable that the work of locating the gun pintles with reference to the base line should be done after the base rings have been set but before the carriage and gun are mounted, and that, when the sites have been selected, the stations for the position finders should also be located and, after the installation of the instruments, their position and that of the guns with respect to them verified.

This method was first tried. Bore sights were designed by the author and made, one for the muzzle and one for the breech, in which cross-wires may be so adjusted as to indicate the true center or axis of the bore at each end. Placing the eye at the one in the breech, the gun was traversed until the thread of the muzzle sight bisected the object whose azimuth was known. A distant lighthouse tower was usually taken for this purpose.

In practice it was found extremely difficult, however, to set these wires over a distant point with any degree of accuracy, in this way. This is due, first of all, to the thickness of the threads when compared with the indefiniteness of the object in the dim distance, and secondly, to the very pronounced parallax which is made manifest when attempting to prolong by eye the line made by two vertical wires, 40 ft. apart, to what is practically an infinite distance.

The next idea presenting itself was to use a telescope in connection with the gun; this to be fastened either directly in the bore at the breech, or attached to a bracket alongside and close to it. The difficulty that arose here was the extreme refinement required to assure the absolute parallelism of the axis of the gun with the axis of the telescope, a matter that might demand more time and attention than the adjustment of the gun itself. A number of other methods were suggested, but all were based on the principle of working from the gun outward.

It was then that the author, who has had some experience in the manufacture of surveying instruments, conceived the idea of reversing the process and working from outward into the gun; that is, collimating it with an instrument exterior to it, a method somewhat similar to that employed by instrument-makers in adjusting a transit by mural collimators within a comparatively small space.

This method has proved very satisfactory, for it admits of discovering discrepancies that would escape any other method of observation less rigid. It will furnish the material or data for the construction of curves of error from which corrections may be obtained for any position of the gun.

To use this method requires a first-class engineer's transit with a vertical arc, which must be in perfect adjustment in all its parts, if it is to serve as a standard with which the gun is to be compared.

This method of mutual collimation and comparison is one so simple and so easily applied that its very simplicity

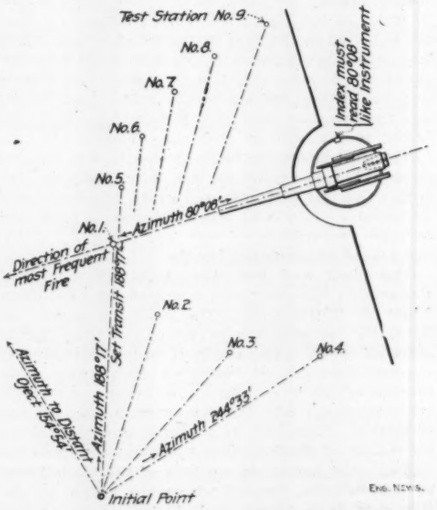

Fig. 3. Plan of Test Stations on Parapet from which Gun is Adjusted.

and freedom from theory would suggest it as the only practical solution of the problem. It has many advantages over any other, the principal one being that it may be used at short range in confined places, under atmospheric conditions when distant objects are shut out. It requires only two men to assist the observer in obtaining very accurate and detailed results speedily and with less effort than by any other method. It admits of a systematic record, and it supplies its own checks, so that serious errors are practically impossible.

The method which will now be described in detail has been termed by the author, for want of a better name,

"ADJUSTMENT OF ARMAMENT BY RECIPROCAL BEARINGS."

Preliminaries.—Before beginning actual work a meridian must be laid out with accuracy in some suitable locality, or, what is the same thing, the azimuth from some fixed point to one or more permanent distant objects must be determined by any known method, such as the observation on circumpolar stars at culmination or elongation. After obtaining the principal meridian it is a simple matter to plant a monument near every battery from which other azimuths may be observed to a number of adjacent points. These monuments will serve as the initial points for battery adjustments and should be carefully preserved.

Preparing the Gun.—A gun ready for this test must have its bore-sight put in. This is placed in the muzzle and consists of a diaphragm to which the cross-hairs

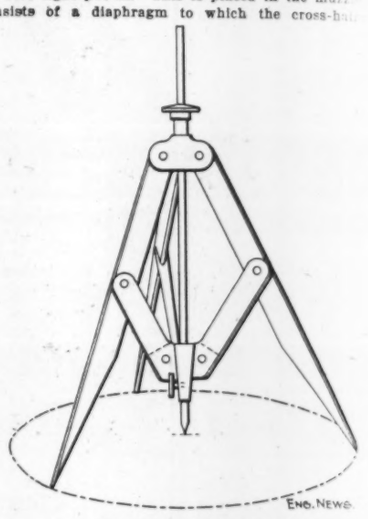

Fig. 2. Centering Tool.

secured. (See Fig. 1.) This diaphragm is adjustable within a ½-in. brass ring, 2½ ins. inside diameter, into which four legs may be screwed. Sets of legs of different lengths are supplied with the sight in order to accommodate it to any caliber. After setting it in the muzzle and tightening up the legs to secure it, the diaphragm is moved by means of the capstan-headed screws until the crossing of the wires is in the true center of the bore. Repeated measurements with a pair of calipers from the circumference of the bore determine this point very accurately.

To facilitate this the author has had made a three-legged centering tool (see Fig. 2). By simply opening the legs they form equal radii from the sliding pin in the middle, the point of which indicates the true center.

The bore-sight once set and adjusted fixes the center of the bore at the muzzle end. It is necessary now to do the same thing at the breech end, and the original intention was to open the breech block and place a similar sight there. It was found, however, that the vent, passing through the entire length of the obturator spindle and obturator head, is in the mathematical center of the breech, and as this hole appears as a small point of light when looking into the muzzle of the gun, it solved the problem of centering in the most simple and practical manner. All that is necessary is to keep the vent clear. If the background should be too dark to see the hole well, light may be thrown into it from the rear either by a mirror, from the sun, or with the aid of a lantern. The author has had no difficulty in recognizing or defining this point in any gun or mortar. A piece of white paper or a handkerchief held an inch or two from the breech will often illuminate the hole sufficiently to recognize it very distinctly several hundred feet away.

This point of light in the deep end of the bore, and the cross-wire at the muzzle face furnish the line of collimation of the gun.

The bore sight is put in readily from the parapet; a disappearing gun must be tripped for the purpose.

Establishing the Test Stations.—To test the gun in azimuth it is necessary to place a number of stations on the parapet, from 50 to 100 feet from the interior crest or so as to be about 75 feet from the muzzle end of the gun. These stations may be arbitrarily chosen, but from them an instrument must command a clear and distinct view of the inside of the gun from muzzle to breech.

One station is placed in the line of the right limit of fire, another in the line of the left limit; and between them as many more as we please; one estimated at every twenty degrees of arc is usually more than sufficient unless gun errors are detected between these stations that would lead one to set them closer.

For a gun commanding an arc of fire of 180°, nine or ten occupied stations develop the characteristics of its motions with sufficient detail. In the case of an all-around fire, as in mortars, the stations are placed in such

available points as the top of the earth slopes and the edge of the pit will afford; four to a quadrant are usually enough. To each of these stations, called test station No. 1, No. 2, No. 3, and so on, an azimuth is carried from one of the known monuments or initial points already referred to. The known monument is occupied by a theodolite which is pointed with the proper horizontal reading to some distant object previously determined, and readings are taken to all the test stations, which indicate the true azimuth from the initial point to each one. These are carefully noted, whereupon the observer goes to the battery where the gun has been prepared for him in the meantime by his assistants. (See Fig. 3.)

The Adjustment.—The theodolite is now placed over one of the test stations. It is immaterial which one of them is occupied first, but it has been found good practice to begin with the one lying in the direction of the most frequent fire of the gun, say towards the approaching sea channel, and to set the gun's azimuth index correctly to this, allowing any error due to the gun's eccentricity or faulty graduation to fall in directions where least fired.

Assuming now that test station No. 1 is occupied, the theodolite is pointed to the initial monument, which the observer has just left, and this pointing is made with the same reading in azimuth as that obtained from the initial monument to test station No. 1. The theodolite is thus oriented to read reverse azimuths, or, in other words, it gives us bearings from the object to the instrument instead of bearings from it to the object, as usual.

The observer is now ready to turn his instrument upon the gun, where men are stationed to traverse it to the right or to the left, and elevate it or depress it as directed by him.

The mechanism of these heavy masses works with such precision that it is not at all difficult to move the gun to the extent of half a minute in either plane, and when correctly set its inertia is such that if the handles are not touched it will remain so indefinitely.

The observer at his instrument and the men at the gun (at the command of the former) now manipulate their parts until the line of collimation of the gun and that of the thedolite lie in the same vertical plane, the contact being made at the intersection of the cross-wires in each case. The instrument man will bisect with his cross-hairs the cross-wires at the muzzle of the gun, and these in turn must bisect the vent hole at the breech at the same time.

A good telescope, by a little focusing, will see the wires and the vent hole very distinctly, and the observer will be able to regulate the finest contact of these two points, while the men become so expert that they will be able by a dainty touch of the handles to give the gun the finest shade of motion in either azimuth or vertical plane.

When this is done the theodolite and gun should read alike; the azimuth should be the same in either case, the instrument's reading being that from the gun to the theodolite. (See Fig. 3.)

The vertical angles should also be alike but of opposite signs, i. e., the theodolite telescope elevated or plus, gun depressed or minus, and vice versa. (See Fig. 4.)

The observer now steps into the gun emplacement and adjusts the brass index plate so as to read the azimuth recorded by his instrument. If the graduated band has not been marked he stamps the proper figure on the nearest degree line.

Thereupon the vertical angles are compared and the gun's pointer for this plane is also adjusted if it should show any material error.

Before the instrument is removed from a station the so-called vertical test of the gun is made. The gun lying in the same vertical plane with the transit, it is obvious that it must follow the motion of the telescope without the slightest deviation from the wire contact at the muzzle.

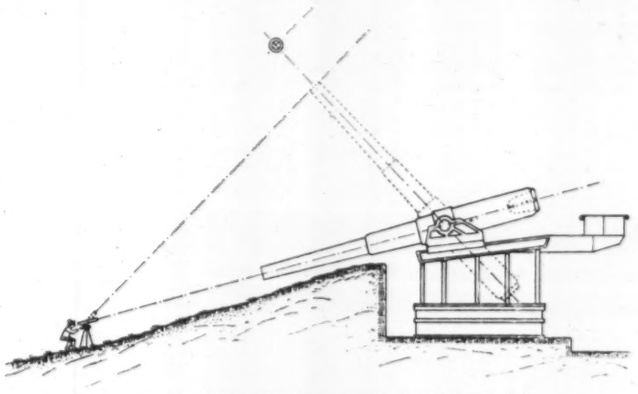

FIG. 4. ADJUSTMENT OF GUN'S VERTICAL ARC.

To prove this the gun is elevated to its highest limit and again slowly depressed as far as it will go to the interior crest, while the telescope follows it very carefully to watch the wire contact. It is evident that if the gun be truly mounted it must remain in the plane of the telescope, and that any deviation therefrom will become apparent at once. (See Fig. 4.)

One not familiar with the accuracy of these machines of coast defense would naturally look for errors in a test as critical as this. But it would astonish anyone to try this and see the result. A gun or mortar that has not a true vertical motion is indeed rare, and any deviation at all is usually so slight that the breadth of the cross-wire will cover it. Unless a transit be of fine quality and accurately adjusted, one would be led to seek for errors in the instrument rather than in the gun, so firm becomes one's faith in the accuracy of these motions.

These three observations having been made, viz: for azimuth, elevation and verticality, the theodolite is removed from test station No. 1, is placed over test station No. 2, and the same process is repeated as described above. It must be clear that after the occupation of eight or ten stations judiciously chosen, the data thus collected become sufficient to obtain a good knowledge of the gun's working parts. It is the author's custom to plot the results on coordinates of azimuth and error, and to develop an "error curve," from which the error for every even 5° or 10° may be taken for the entire field of fire. No method heretofore applied has furnished this information.

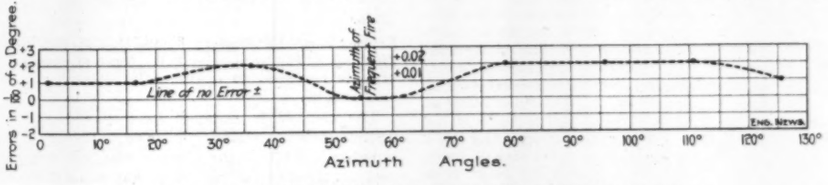

FIG. 5. SAMPLE OF ERROR CURVE, PLOTTED FROM TABLE 1.

An adjuster becomes very expert. The author has been able to obtain the errors of four mortars in one pit, all around the horizon, in six hours. A large gun may be completed in about two hours. The method therefore suggests itself as one that should be frequently applied. That is, every gun should be run through its adjustments from time to time, particularly after firing, to note whether a violent disturbance has any noticeable effect upon its adjustments. We are enabled thereby to trace up all the individual characteristics or idiosyncrasies that the huge mechanism may have at any time, or which it may develop in the future.

A check may be applied entirely independent of the method here described, one which the author has always used to detect any possible grievous error in stamping. An azimuth is calculated from the gun pintle to some known object on the opposite side of the Harbor, say a distant lighthouse tower whose geodetic position is known. The gun is set to read this azimuth as in indirect firing. It is evident that the gun must now point to the object, which may be tested by looking over its sights. And this again affords a means of adjusting the gunner's telescopic sight at the side brackets. Lay off the correct azimuth by index to a known distant object. The gun now points to it. The telescopic sight should fall a trifle to one side of the object, either to the right or to the left, according to the mounting of the telescope in reference to the gun. It is about 3½ feet to 4 feet from the axis of the bore. The displacement of the telescopic sight is measurable by its deflection scale and should be:

For 1 mile, in 3½ feet, 0.04°; in 4 feet, 0.044°.
For 2 miles, in 3½ feet, 0.02°; in 4 feet, 0.022°.
For 3 miles, in 3½ feet, 0.015°; in 4 feet, 0.016°.
For 4 miles, in 3½ feet, 0.01°; in 4 feet, 0.011°.

Knowing the distance of the observed object, the amount of telescopic displacement becomes known and should correspond to it. If it does not, the axis to the telescope is not parallel to the axis of the gun and should be made so by turning the standard on which the telescope is hung.

In the work of defense in San Francisco Harbor the entire armament has been tested by the author in this manner. The errors detected in azimuth are usually small, averaging from 2/100 to 3/100 of a degree; an error of 5/100 of a degree, or 3′ is considered large in long-range rifles. Attention has been called to the fact that the indices are so set as to show no error in the direction in which the gun is to be fired most, while they are thrown into directions of least fire or short range, where an error in azimuth would be of no serious consequence. The method admits of doing so, and this alone is a great advantage, and one that ought to recommend it very strongly.

Errors in azimuth are due either to eccentricity, to faulty graduation or to a combination of the two causes; but principally to errors in graduation, for the brass bands are graduated in sections of arc and mounted separately around the periphery of the base plate. It is readily seen that in the abutting of these arcs and in their fitting, though done with the greatest mechanical skill and care, a certain amount of error must be unavoidable. But it is not that there are errors, but that the errors are confined to such narrow limits which is astonishing.

The method also admits of graduating the brass azimuth bands after they have been put in place, correcting for all errors in the graduation itself. It is perfectly possible to graduate a circle free from all error, the question remaining, of course, whether after firing, the gun will remain the same in its motions. Errors of graduation alone may be entirely eliminated.

The vertical arc is tried from every test station, so that in this case, too, we should be able to detect whether it holds its adjustment in any direction of the field.

The verticality test assures us that the gun does not change its azimuth when elevated to the highest angle, and whether this may be relied upon to hold good in any position or direction.

After the data thus gathered and recorded in a book ruled for this purpose have been plotted, and the error curves have been developed, a table is made out showing the errors for every even 5° or 10°, which is furnished to the battery commander for his guidance.

Incidentally it may be mentioned that it is often found desirable to look into a gun to view the mushroom head of the obturator when the breech is closed. The handiest instrument the author has found for this purpose is the well-known Helmholtz concave mirror used by laryngeal specialists in examinations of the human throat. It is possible to throw light into the long throat of the gun without being in one's way, and a close inspection may be made of the inner tube by concentrating reflected light to any particular part of it.

In indirect firing, the position of a moving target is kept track of by position finding instruments working either on horizontal or vertical base lines. The instruments may be long distances away from the gun, but the results of their observations lead to obtaining the azimuth of the target from the gun and the direct distance between them, so that the gunner may be able to give his gun the required direction and elevation without seeing the target at all. This system may be followed in the case of any battery, but it is absolutely compulsory in some cases, as in mortar batteries, where the armament lies in low pits, and where the method of aiming known by artillerymen as Case III. is the only available one.

This shows that it is essential to lay off correct angles with a gun, and that it may justly be compared to a surveying instrument, whose eccentricities and errors should be known in order that its functions may be properly fulfilled.

TABLE I.—SPECIMEN RECORD OF ADJUSTMENT.

Test Station.	Reverse Azimuth to Initial Point.	Reverse Azim. of Instrum't into Gun.	Gun's Reading when collimated with Transit.	Gun's Error in Azimuth.	Vertical Angle of Transit.	Vertical Angle of Gun.	Gun's Error in Vert. Arc.	Motion in Vertical Plane.	Remarks.
No. 1	51° 31′	126.11°	126.12°	+0.01°	+0° 16′	—0° 14′	+02′	Tested and found true.	Right limit of fire.
" 2	49° 00′	110.42°	110.44°	+0.02°	+1° 11′	—1° 09′	+02′	" " " "	
" 3	47° 18′	98.77°	96.79°	+0.02°	+1° 43′	—1° 41′	+02′	" " " "	
" 4	45° 15′	78.53°	78.55°	+0.02°	+2° 11′	—2° 09′	+02′	" " " "	
" 5	42° 55′	54.91°	54.91°	+0.00°	+2° 48½′	—2° 46½′	+02′	" " " "	Direction of frequent fire.
" 6	41° 00½′	36.58°	36.60°	+0.02°	+2° 34′	—2° 32′	+02′	" " " "	Index set to true Azimuth.
" 7	38° 43′	16.08°	16.09°	+0.01°	+2° 14′	—2° 12′	+02′	" " " "	
" 8	36° 41′	1.47°	1.48°	+0.01°	+1° 58½′	—1° 56½′	+02′	" " " "	Left limit of fire.

The gun's calculated azimuth to object previously determined is 35.15° +0.02° for error = 35.17°. This was found to agree.

The gun's telescopic sight falls to the right by 0.02°; the error is due to non-parallelism of the axis of the telescopic sight, which should be corrected.

NOTE.—Test Station No. 5 was occupied first and the gun's index set to this azimuth, 54.91°.

BRITISH REFUSE DESTRUCTORS.

(Editorial Observations.)

The notes on British refuse destructors here begun were originally made during 1904 by a member of the editorial staff of this Journal while abroad for the purposes of studying municipal engineering and sanitation on behalf of Engineering News. The notes have been supplemented and checked by Goodrich's "Refuse Destructors and Power Production," and by a few other sources of printed information, but for the most part they are the result of personal observations and inquiries. No attempt has been made to give detailed descriptions of all the destructors visited, the object being to present a general idea of the conditions found. It is also important to note that the destructors visited were for the most part chosen because the writer was in their vicinity. They therefore represent good, bad and indifferent, and can by no means be considered as the best "show plants" of the several makes of furnaces or as the best examples of heat utilization for generating electricity, pumping sewage or water. In fact, by the accident of an itinerary arranged with another object in view, it happens that the notes are particularly weak on refuse destructors combined with electric light and power stations.

Some twenty different destructors, located in sixteen cities and towns were seen during March, April and May, 1904, a sufficient number to give one a fair general idea of destructors abroad as compared with garbage furnaces at home (see editorial in this issue). Two continental destructors are included, for although not on British soil they are British in design and build.

Destructors in Four London Boroughs.

The Metropolitan County of London is composed of the cities of London and Westminster and 28 boroughs in addition. About half of these municipalities have refuse destructors and of these four were visited by the writer.

THE COMBINED REFUSE DESTRUCTOR AND ELECTRIC LIGHTING PLANT AT SHOREDITCH.

Exaggerated claims for the production of electricity from municipal refuse were made when the combined refuse destructor and electric lighting plant was opened at Shoreditch in 1897. It was asserted that thenceforth the refuse of a city would afford ample power to light it by electricity, thus greatly relieving the sanitary and lighting departments and the overburdened taxpayers. Some basis, at least, for these assertions was afforded by remarks made at the time by Lord Kelvin. The enthusiasm over this alleged wonderful advance in municipal sanitation and economy reached the United States and was spread by the editors of the daily press, quite regardless of the differences in British and American conditions. A few figures presented in Engineering News for Aug. 26, 1897, were sufficient to show some of the limitations of such combined installations in America. A half dozen years have elapsed and the cities of the United States have done practically nothing towards the production of power from refuse. In Great Britain and portions of Continental Europe, however, the majority of the refuse destructors are developing steam for works purposes and in addition most of the destructors built during the last few years are combined with electric light or railway stations, sewage or water-works. Nevertheless, the word has gone out that the Shoreditch combined works are a failure. To a degree this report seems to be true, but if so, it is largely because the works were too ambitious in scope and because too much was claimed for them by their promoters before the works had been given the test of some months or years of operation. Such, at least, I found to be the opinion of some of the men in England most competent to pass judgment on the Shoreditch plant.

Before describing the works or giving any further opinions regarding them, I wish to state that I saw the destructor under conditions unfavorable for obtaining exact information. Mr. J. Rush Dixon, Assoc. M. Inst. C. E., Borough Surveyor, was unable to see me at all; Mr. O. B. Richardson, Manager of the destructor, was not to be found; and the man who conducted me over the works said he was unable to give me some of the detailed information which I desired.*

*The lack of information due to the cause just named has been partly made up since by the paper sent by Mr. H. Newton Russell, M. Inst. M. E., Borough Electrical Engineer of Shoreditch, to the joint meeting of the British Institution of Mechanical Engineers and the American Society of Mechanical Engineers at Chicago in May and June, 1904 (Vol. XXV., Trans. Am. Soc. M. E.). The paper was entitled "Refuse Destruction by Burning, and the Utilization of Heat Generated." The paper was devoted chiefly to a description of the Shoreditch destructor and has been used to supplement my notes taken at Shoreditch.

Shoreditch is a central London borough having a population of 118,705 on an area of only 640 acres, of which only 6½ acres is composed of open spaces. The refuse destructors comprise twelve Fryer's improved top-fed cells, with Boulnois, Wood & Brodie's charging apparatus built by Manlove, Alliott & Co., of Nottingham, and put in operation in June, 1897. Kincaid, Waller & Manville, of Westminster, were employed as engineers for the combined refuse destructor and electric works. The rated capacity of the plant is 100 long tons a day. The average amount burned is about 85 long tons a day, running as low as 60 tons in summer and as high as 140 tons in winter. The cells are arranged six back to back on either side of the main flue and between each parallel pair of cells is a Babcock & Wilcox boiler, making a total of six boilers. Each boiler has a heating surface of 1,300 sq. ft., and a grate surface, for independent firing, of 27 sq. ft. From the dilapidated appearance of this apparatus I thought it was not in use, but the man who showed me about said that it was in service. This apparatus attracted so much attention when it was installed that I will quote, with slight abbreviation, what Mr. Russell says about it and closely allied subjects in his recent paper (mentined in the footnote herewith).

A somewhat novel system of storing hot feed-water is in use (sometimes called thermal storage). The reason that led to its adoption was that, at the inception of the combined scheme, it was not thought that for some time at least the demand for electric current would be very great, and that during the hours of daylight, when refuse was of necessity being burned, it was feared that some of the heat would be lost, owing to the small demand for steam.

It was therefore decided to instal Halpin's Thermal Storage system, with a view of storing up heat in the form of water at a high temperature. The storage vessel was originally connected to the main line of steam pipes, with a view to it being gradually filled by pumping in cold feed-water, which would be heated by means of spare heat generated in the refuse furnaces during the daytime. The intention was that a portion of the steam raised in the boilers of the destructor plant would be used as required for the engine driving the electric generators, and the balance passed over to the thermal storage vessel, where it would part with its heat to the feed-water. The engines were designed to have adjustable cut-offs, so as to drive their full load with pressure varying from 200 lbs. to 120 lbs. per sq. in. The object aimed at was to fill up the thermal storage vessel at times of low load with water at a temperature corresponding to a pressure of 200 lbs. per sq. in., and at the time of greatest demand for current, not only feed the boiler from the storage tank, but by the evaporation of the hot water as the pressure fell steam would be given off to augment that supplied by the ordinary boilers. The process would proceed until the pressure reached the lowest point, i. e., 120 lbs., by which time it was thought that the time of maximum demand would have passed, and that the ordinary boilers would be able to cope with the load. In practice things worked out very differently. First it was found that pumping cold water into the vessel into which high-pressure steam was being admitted caused such a water hammering that the practice had to be discontinued forthwith, and it was found necessary to partially heat the feed-water by passing it through a Green's economizer before putting it into the thermal storage vessel; this, however, effectively got over the difficulty. Secondly, by the autumn of 1897 the demand for steam during the daytime had reached nearly the limit of heat it was possible to get from the refuse furnaces; so, having nothing to spare from that source, no additional thermal storage vessels were necessary.

The boiler-feed is now furnished by a Weir pump, which forces the cold water through a Green's economizer, where it is heated to a temperature varying with the load, although at light loads a maximum temperature of 250° F. has been reached. The feed then passes into the thermal storage vessel, fixed at a level of about 20 ft. above the boilers. This vessel is simply a cylindrical shell, 30 × 8 ft., which is used for storing, during the hours of light load, hot water with which the boilers are fed directly by gravity.

Most of the lime in the feed-water comes down [illegible] feed-storage vessel; the amount taken out of the [illegible] after a run of seven months was little short of [illegible] after being dried. The deposit in the economizer [illegible] was less than 1-16-in. in thickness; it was of a [illegible] nature than that in the feed-storage vessel, and [illegible] removed by a scraper. The boiler tubes were free, [illegible] examined and were found fairly clean, the deposit [illegible] tubes amounting to an average of 3-32-in.

This system of feed-storage has undoubtedly contributed considerably to the success of the plant generally; it enables the engineer in charge of the steam-raising plant to store hot feed-water during about 18 hours out of [illegible] so that at the time of maximum load the vessel is [illegible] two-thirds full of feed-water at a pressure and temperature equal to that of the boilers.* Tests have been made on several occasions, when the demand for electricity has been within the range of the refuse furnaces to supply the necessary heat, and when, of course, [illegible] was used. The result showed 0.95 lb. of water evaporated at a steam pressure averaging 130 lbs. for 1 lb. of refuse burned. A considerable reduction must, however, be made in these figures when taken over say twelve months. Damp weather (which affects the quality of the refuse), low barometric pressure, choked flues, warped doors, the starting up of furnaces, etc., may easily bring down the average results over a lengthy period to 0.5 lb. of water for 1 lb. of refuse burned. The existing vessel has, however, proved most serviceable for the storage of hot feed-water, and as a means of removing the impurities from the feed-water before it reaches the boiler. The economizer was not erected until some time after the works were opened, as it was not anticipated that the temperature of flue-gases would warrant its insertion. However, after the plant had been running steadily for some time, and careful tests had been taken, it was found that the flue-gases at the base of the chimney had a maximum temperature of 700° F.

The chimney is of brick and is 150 ft. high. Both Sturtevant fans and steam jets are available for maintaining a forced draft. Mr. Russell prefers the fans. There are three of these, designed to give 8,000 cu. ft. of air per minute. They are driven by an electric motor. All three of the fans are not required except during the heaviest loads. The air for the fans is drawn from the top platform, in order to take advantage of the greater heat of the air at that place.

The refuse is collected by the borough in four-wheeled wagons and, the site of the works being so restricted and land there so valuable that an inclined driveway was considered impracticable, the refuse is dumped at the ground level into tip cars each holding one wagon load. The cars are raised on electric lifts or elevators, run forward on a trolley track and dumped into charging cars or else into a storage bin. The charging cars are run over the destructor feed holes and emptied by means of flat slides in the bottoms of the cars. These cars are also moved by electricity. On the basis of 25,000 long tons of refuse burned per year an average of 0.52 KW. hour of electric energy is required to operate the lifts or elevators and trucks.

The clinker is dumped in a paved yard and quenched with water. It gave evidence of good burning. Most of the clinker was not being utilized at the time of my visit, but some was being used for road making.

My visit was at about 3 p. m., on Thursday, March 17, 1904. I saw very little garbage proper, but was told that there was more the first day of each week. All the refuse was dry.

The dust in the destructor building was thick, both in the air and wherever it could find lodgement. In fact, it was annoying. No odor was observed and the chimney top was free from smoke.

The cost of the destructor, exclusive of site, is given by Mr. Russell in his paper, already mentioned, as about £15,000, or some $75,000. This includes two-thirds of the cost of the chimney, the other third being charged to the electricity works. The total cost of the chimney was £2,790, or about $13,550. In Goodrich's "Refuse Disposal and Power Production" (London, 1904), the cost of the destructor, also exclusive of site, is given as £20,527, or about $100,000. The 13,450 sq. ft. of land comprising the destructor site cost 13 shillings, or about $3.25 per sq. ft., or a total of $42,360.

*For full details of Thermal Storage System as applied to ordinary steam raising plants see Paper on "Economy of Fuel in Electric Generating Stations," by H. McLaren, M. Inst. M. El., Proc. Inst. M. E., July 29, 1903.

... to the cost of operation, Mr. Russell, in his ..., says:

... amount of refuse destroyed is between 25,000 and ... long tons per annum. The residue (or clinker) ... to from 33 to 35% of the weight. The cost for ... for burning the refuse is very high, compared with ... at other destructor plants, and is one of the most ... factors for consideration. The nearer a destructor ... the center of a large city, the greater will be the ... bill, and this fact must be borne in mind in con... any new scheme:

	Per long ton. s.	d.	cts.
... for handling and burning refuse, including yard men, average	2	6	61
... and establishment of charges	0	4½	9
... and maintenance of cells and ... and cost of engineering stores	0	10	20
Total	3	8½	90

The average number of men employed in actually handling the refuse (per shift of 8 hours):

Furnace men	4	
Top men	3	
Lift men	1	daytime only.
Yard men (laborers)	2	
Foreman in charge of shift	1	

The above figures are for the fifth year's working, when considerable repairs were necessary to the furnace, linings, doors, etc.

The works are run on the eight-hour-shift system, seven days per week.

The amount of electric energy consumed in the burning and handling of 25,000 long tons of refuse is as follows:

	Units per tons.
Electric fans	4.0
Electric lifts and trucks	0.5
Electric lighting	0.48
Total	4.98

The operating expenses, as given above, do not include the disposal of clinker. At some destructors clinker is considered as a source of revenue, but it is doubtful whether proper debit charges are, as a rule, made against it. Mr. Russell states in his paper that where destructors are located in the center of large cities clinker disposal

is a difficult and expensive matter—it is usually found impracticable to use more than a small portion for slab and mortar making. The greater portion has to be removed in vans to the outskirts of the city. This in the case of Shoreditch costs 2s. or 50 cts. per ton of clinker, and should be taken into account in the total cost for disposal. When building operations, road-making, etc., are going on extensively in the neighborhood the clinker from refuse destructors is of considerable value. When properly treated it may be made into most excellent paving slabs, bricks, concrete and mortar.

At Shoreditch the clinker amounts to from 33 to 35% of the original refuse. Therefore when it has to be got rid of by carting away its disposal, adds about 17 cts. per ton to the cost of the destructor operations. This brings the total cost of operating the destructor up to $1.07 per long ton. The exact amount to allow for capital expenses is uncertain, owing to the differences in capital outlay as given by Mr. Russell and by Mr. Goodrich. But taking Mr. Russell's figures (which are the lowest), we have, say a capital outlay of $115,000, which at only 7% for capital charges would amount to about $8,000 or some 30 cts. per long ton on 25,000 long tons per year. This would bring the total cost of refuse destruction up to $1.37, or with a slight allowance for contingencies, to $1.50 per long ton.

As an offset to this, there is the value of the steam delivered to the electricity works and to other municipal buildings adjoining the destructor; but unfortunately Mr. Russell neither states what this amounts to nor gives figures from which a computation can be made. He does say that the exhaust steam from the non-condensing engines in the electric generating station "is put through heaters which supply all the hot water necessary" for the public baths and wash house; that the public library is heated by exhaust steam from the feed pumps; and that live steam from the boilers is supplied for boiling clothes in the wash house. For the live steam a yearly rental of nearly £250, or about $1,200, is charged, but whether this steam is from the destructor boilers or from the supplementary boilers is not stated. Nor is there anything to indicate what percentage of the steam used by the engines in the generating station is from the destructor boilers and what from the supplementary boilers. It is interesting to note that the public baths and wash house include one swimming pool, 100 × 40 ft. and another 75 × 34 ft., 76 bath tubs and 50 troughs for washing clothes.

A brick wall separates the electricity works from the destructor building. The total capacity of the electric station is about 2,500 KW. Independent coal-fired boilers, as already intimated, supply the steam needed beyond the yield of the destructor boilers, which is, of course, considerable.

THE TOOTING OR WANDSWORTH DESTRUCTOR.

The destructor at Tooting, in the London borough of Wandsworth, is provided with direct charging apparatus.

Wandsworth has a population of about 230,000, and the large area of 14½ square miles, of which nearly two square miles are in commons or other open spaces. The refuse destructor serves only two or three districts of the borough, the balance of the refuse being either carted or barged away. Mr. H. J. Marten is surveyor for the portion of the borough in which the destructor is located, and was the inventor of the charging apparatus. Mr. George Cowell is manager of the destructor, and showed me around the plant.

The destructor was erected in 1899, by Meldrum Bros., of Manchester. It consists of four Beaman & Deas top-fed cells, with the direct charging apparatus already mentioned. Each cell has an effective grate area of 25 sq. ft. The chimney is 150 ft. high and a fan is used for forced draft. A Babcock & Wilcox boiler with a heating surface of 1,619 sq. ft. supplies steam for works purposes, including electric lights for the works and for three or four adjacent streets. The cells are arranged in two pairs and have a combined rated daily capacity of 70 long tons. The building is of brick, with a steel and slate roof. There is an inclined stone-paved ramp, the tipping floor is large and well paved and the clinkering floor is also paved. Water-closets and baths are provided for the men, and I was told that the baths are used daily. There is also a mess-room for the men, and there are good stables, with paved floors, for the horses.

The borough collects its refuse in four-wheeled tipping wagons and all refuse brought to the destructor is weighed. Extra vans are provided for most of the storage required, but there are some small storage pockets alongside the charging hoppers into which the vans can be tipped. The tipping floor is spacious enough to store a number of refuse wagons and an extra horse is provided for moving the stored wagons.

The charging apparatus consists of a wrought-iron hopper, with a sliding bottom 2 ft. wide and 5 ft. long. When a wagon load is to be fed into the destructor the bottom of the hopper is slid to one side by means of a hand-wheel and lever, operated from the tipping floor. The wagon is then backed up against the tipping beam, the wheels moving in grooves designed to bring the wagon to the same position each time, thus ensuring that the refuse will be tipped directly through the hopper onto the charging grate. The seal to the hopper is then closed. The charge is pushed onto the fire, as desired, from the rear, enabling the operator to keep cooler than if he were compelled to rake the charge over the fire from the front.

The cells are fed and clinkered about once in two hours. The clinker is raked into barrows, wheeled out and dumped in an unpaved yard. Water is used to cool the clinker sufficiently to enable the men to get about comfortably. The clinker is used to grade streets ready for macadam and the finer portions are screened out and utilized for unpaved footpaths and as a base for sidewalk flagstones. In addition, some clinker is sold to contractors, who call for it and pay two shillings, or 48.6 cts., per load of about 1½ cu. yds., or approximately 2,000 lbs. The fine ash from below the grate is sold under like conditions at two shillings per load of 1½ cu. yds., or about 1,570 lbs. The same price is obtained for like volumes of flue dust, weighing about 1,350 lbs.

The large tins, only, are picked out before the refuse is burned. Formerly, the borough flattened all the tins with a steam roller in the destructor yard and placed them beneath the clinker in road-making. At the time of my visit a contractor was being paid 2½ shillings per long ton for removing the tins, which he sorts and sells. The borough has had an offer for crushed or flattened tins of 12½ shillings, or $3.04, per long ton at the destructor yard, or $4.87 delivered at a dock, but the margin between the price offered and the labor cost was considered too small. A contractor, Mr. Cowell said, could make a profit at the figures named, since besides paying his men lower wages, he would "hustle them about a little bit more than we would here."

The destructors are run from 6 p. m. Sunday to 6 a. m. Saturday, during which time they burn about 435 long tons of refuse. The flues are cleaned on Saturdays. One of the four cells is shut down at night. The men work in 12-hour shifts, four firemen in the day and three at night. Only one top man is employed during each shift. These nine men are paid 6½ d., or about 13 cts. per hour. The manager starts the dynamo at night and the top man looks after it. A boy is stationed at the scales and office.

Omitting the boy and the manager, allowing nothing for cleaning up on Saturday, and assuming an average of 435 long tons of refuse burned per week, we have the following as the labor cost per ton:

$$\frac{9\text{ (men)} \times 66\text{ (hours)} \times 6\tfrac{1}{2}\text{ (d.)}}{435\text{ (long tons)}} = 8\tfrac{3}{4}\text{ d.} = 17\tfrac{1}{2}\text{ cts.}$$

The installation, not including the inclined roadway, cost £5,005, or about $24,325.

For lighting purposes outside the building, when the fires are not going, electric storage batteries are provided. A little coal is used Sunday nights, to get up steam to drive the fan for the forced draft.

I visited this destructor about noon of Wednesday, March 23, 1904. I saw scarcely any green stuff in the refuse. I was told that there was comparatively little garbage in winter and little else during the summer. The plant in general was in a clean condition. There were no odors. Only a small amount of light smoke was visible at the chimney top.

A continuous 120-hour test of two cells of this destructor was made on Feb. 2 to 7 (year not given). This test is reported in detail in Goodrich's "Refuse Disposal and Power Production," where it is stated that it was made under ordinary working conditions, mainly to determine the power-producing value of the refuse. With 50 sq. ft. of grate surface and 1,619 sq. ft. of boiler heating surface there were put through the two cells a total of 411,264 lbs. of refuse, including 728 lbs. of tins. Deducting the tins the average amount of refuse burned per hour was 3,421 lbs. for the two cells, or 68.4 lbs. per sq. ft. of grate surface, and 2.1 lbs. per sq. ft. of boiler heating surface per hour. The residuals were 38.2% of the refuse by weight, of which 37% was clinker, 0.4% ashes from beneath the grates, and 0.8% flue dust. The total amount of water evaporated was 419,833 lbs., which was 1.02 lbs. of water to 1 lb. of refuse burned. On the basis of a temperature of 212° F. the evaporation was at the average rate of 1.24 lbs. of water per 1 lb. of refuse and 2.6 lbs. per sq. ft. of boiler heating surface. Some of the average temperatures were as follows: At the boiler inlet, 1,698° F.; boiler outlet, 637; chimney base, 629; feed water, 46° F.

THE WESTMINSTER DESTRUCTOR.

Standing on Westminster Bridge, close by the Houses of Parliament, and looking across the river to the left, one may see the chimney of a destructor in which is burned the refuse of a portion of the city of Westminster.

Westminster has a population of about 185,000, on an area of four square miles. Its population ranges in character from the royal occupants of Buckingham Palace to some of the poorest tenement dwellers in all London. The destructor is located in a manufacturing and dock district. Mr. W. J. Bradley,* M. Inst. C. E., is city engineer of Westminster, and Mr. Arthur Ventries,† Engineer of the Highway Department, controls the cleansing department, under which the destructor comes. Mr. G. Holt is foreman of the destructor.

The refuse destructor includes six cells, in three pairs back to back, erected in 1900 by the Horsfall Destructor Co., of Leeds. The cells are top-fed,

*City Hall, Westminster, S. W.
†Vestry Hall, Piccadilly, Westminster, S. W.

through a special direct charging lid, and have a combined grate area of 252 sq. ft. The chimney is of brick, 92 ft. high. Steam jet blowers are used to produce a forced draft. A Babcock & Wilcox boiler, with a heating surface of 1,426 sq. ft., is placed behind the cells. The boiler supplies steam to drive a mortar mill and also a dynamo for lighting the works. Storage batteries were being installed at the time of my visit, and the lighting system was to be extended to include the stables, office, and the foreman's cottage.

The refuse is collected by the city in four-wheeled tipping wagons, with boxes of wood. All the refuse is weighed at the entrance to the destructor. The vans hold some 2 cu. yds. each, and I was told at the weighing office that an average load would weigh 2,800 lbs. The rated capacity of the destructor is 72 tons in 24 hours, and it was said that an average of about 70 tons a day is burned.

The dumping floor is at a comparatively slight elevation above Commercial St., and is paved with wood blocks. The inclined approach has a stone pavement.

The wagons are tipped directly into the cells, one pair of which can receive two loads at a charge. The refuse is subsequently pulled forward from the lower or stoking and clinkering floor. Each charging hole is provided with a counterbalanced lid, lifted by a wheel and endless chain. The lid is seated in a water seal, to retain smoke and gases, and a special cover is let down to exclude dirt from this seal when the cells are being charged.

The hot clinkers are dropped into skips, running on an overhead trolley from the clinker doors to a lift, or elevator. At the top of the lift the skips are conveyed by a second trolley to a mortar mill, or else they are sent some 300 ft. in another direction and tipped into a barge.

The mortar mill has been added since the destructor was built. It consists of a revolving iron pan, about 8 ft. in diameter and 15 ins. deep, in which are two heavy rolls working on a horizontal shaft. At the time of my visit all clinker not used by the city for filling or otherwise was being sold, but formerly some of it had been barged away at the expense of the city. The fine ashes below the grates were also being sold. There is no sale for the flue dust. It was formerly mixed with carbolic acid for use as a disinfectant. I was informed that Mr. Bradley put a stop to what at best seems a doubtful practice, but is still followed at Battersea. All tins pass through the destructor and go away with the waste clinker.

The works are operated in both 8- and 12-hour shifts. There are three stokers on each 8-hour shift who are paid 35 shillings, or $8.50, a week, and two top men on each 12-hour shift who are paid 28 shillings, or $6.80, a week. One of the two night topmen acts as a "carman"; that is, he uses a horse to bring stored wagon loads of refuse into position for tipping. In addition to the force named there is a single night and day foreman, whose wages I did not learn, and two weigh clerks, whose wages are not charged to the destructor.

I visited this plant about 5 p. m. on Friday, March 25, 1904. No odor whatever was noticed, and there was but little smoke, and that light, coming from the chimney. Smoke and dust were pouring out around one of the charging lids, but I was told that the lid was temporarily out of order.

There was but little green stuff in the refuse, and I was informed that in winter the refuse is usually very light in weight, containing large amounts of paper and ashes, while in summer the green stuff runs up to half the total amount collected. Some collections are now made at night. The cells are run some three months at a time without being shut down, unless special repairs are required.

A test of the whole six cells was made by Mr. Bradley on Dec. 2 to 4, 1902. During the 45½ hours of the test 310,828 lbs. of refuse were burned, which was at a rate of 27,476 lbs. per cell per 24 hours, or 27.2 lbs. per sq. ft. of grate surface. The average temperature observed in the main flue was reported as "over 2,000° F.," and the average temperature behind the boilers as 500° F. With 9 stokers at 35 shillings, or $8.50 a week, and 4 topmen at 27½ shillings, or $6.68 a week, the labor cost was at the rate of 11½ d., or 23 cts. per long ton of refuse burned. The clinker and ash was 24.9% of the original weight of the refuse.

THE REFUSE DESTRUCTOR AND THE UTILIZATION OF CLINKER AT BATTERSEA, LONDON.

The refuse destructor of the London borough of Battersea is one of the older British destructors. It is of the Fryer top-fed type, and was erected in 1888, by Manlove, Alliott & Co., of Nottingham, a number of years before there was any attempt to combine destructors with electric generating stations. There is a boiler, however, in which steam is raised for works purposes. Perhaps the most interesting feature of this plant is the utilization of the clinker residue for various purposes, including the manufacture of artificial flagstones in a hydraulic press.

Battersea has a population of 168,907, and an area of 3½ sq. miles. It is one of the densely populated London boroughs and is notable for its low death rate, its government by working men, and for being the home of John Burns.*

Mr. T. W. A. Hayward is borough surveyor of Battersea, and Mr. Allen Vickers is and for some ten years has been manager of the refuse destructor.

Contract work has long been under the ban in Battersea, and it is rarely employed for refuse collection anywhere in Great Britain. At Battersea, however, the borough not only collects the refuse, but it also manufactures the vans or four-wheeled wagons used for the purpose. These wagons are of wood, are provided with two springs parallel to the rear wheels, and are dumped by means of a screw lift. The sides are so high that a ladder is provided with each wagon for loading, and to lessen the danger of accident the upper ends of the ladders are fitted with hooks and the wagons with side rails. The wagons cost £40, or about $195 each, and are said to be good for 20 years' service. An empty wagon weighs a long ton, and has a capacity of nearly 2½ cu. yds. The weight of such a load, obviously, varies with the character of the material, but is placed at about 2,240 lbs.

The collections of refuse, six days in the week, range from 100 to 140 loads a day. About half of the refuse is hauled to the destructor and the remainder is delivered to a contractor who takes it some miles down the Thames, where it is used for burning brick. This portion of the refuse is dumped on barges by the borough. The contractor shapes the barge loads and the borough measures them and pays the contractor 10 d., or about 20 cts. per cu. yd., for his work. The barges carry from 45 to 80 wagon loads.

In winter there is only a small amount of green stuff in the refuse, and that is gathered chiefly from costermongers on Mondays. I visited the destructor on Thursday, March 17, 1904. The refuse then contained scarcely a bit of green stuff, or garbage proper. I was told that there is more garbage now than formerly, on account of the increased use of gas stoves.

Each load of refuse is weighed as it enters the works, after which it is dumped on the top of the destructors. Here the large cans, only (or "tins," as they are called in England), are picked out, all others going into the fires.

There are twelve destructor cells. Natural draft, only, is used. The chimney is of brick, 180 ft. high. A multitubular boiler supplies steam for operating the clinker crusher and the flag-making machine.

The capacity of the twelve cells is 60 long tons a day, but this is for two eight-hour shifts.

The clinkers are removed once in two hours. The hottest are quenched with water and barrowed out into a paved yard to cool. The largest pieces are broken by hand, after which the clinker is loaded into a barrow and wheeled up an incline to a steam-driven crusher. This consists of two chilled iron toothed rollers. The clinker is crushed to a maximum size of about 3 ins., dropped into barrows, wheeled to a pile and roughly hand-sorted into three sizes. It is expected that an elevator and a revolving screen will soon be added. The coarsest clinker is used for making concrete; the medium for the body of [illegible] walk flags; and the finest either goes to a [illegible] mill or is used in laying sidewalks.

Before the hydraulic press was secured [illegible] considerable quantity of clinker was molded [illegible] and into window sills, lintels, keystones and [illegible] like, for use in the cottages built by the bo[illegible] for housing the working classes. The press [illegible] put in operation late in 1903, and I was told th[illegible] thus far it had given satisfaction. It was supp[illegible] and erected by C. & A. Musker, of Liverpool, [illegible] cost of £1,500, or about $7,300, including hy[illegible]ulic pumps and shafting, but not including an [illegible] engine supplied by the borough.

The slabs or flags are 2 ft. wide and [illegible] ins. thick, and are made in lengths of 2, 2½ and [illegible] ft., to allow for breaking joints in laying.* The body of the slabs is composed of 4 parts of [illegible]um-sized clinker to 1 part of Portland cement, and the upper ½-in., or wearing surface, of 3 parts of granite screenings to 1 part of Portland cement.

The slab molds, of which there are thr[illegible] rest horizontally on a table which revolves on a vertical shaft: while one mold is being filled, the contents of another are being pressed and a third is being emptied. The material which is to form the wearing surface is placed at the bottom of the mold and rests on a perforated plate, made of an aluminum alloy. Above the plate is a piece of brown paper, which serves as a filter paper. The perforated plate gives the top of the flags an irregular appearance which is more pleasing to the eye than a smooth surface. The hydraulic power pumps maintain a pressure of 2,000 lbs. per sq. in. on the slabs for about a minute. Four men can make 20 slabs an hour, regardless of length. The slabs are stacked on edge in the yard for some three months to dry in the open air.

The ashes that fall through the destructor grates, I was told, sell readily at the works for 6 d., or 12 cts., per long ton. They are used for building purposes.

The flue dust is sifted and carbolic acid is added to it to make a disinfectant for borough work. Some of the powder is placed in refuse receptacles, when the latter are wet, and some is given away in pound packages to anyone who calls for it.

The cans, or tins, are flattened, baled and carted away at a cost to the borough of 1½ shillings, or 37 cts., per long ton, as compared with 2½ shillings, or 62 cts., formerly paid. The man who does this sells the tins to an antimony works. The borough has recently had an offer of 22 shillings, or $5.31, per long ton for the tins, delivered to the London Electron Works, Regent Docks, Horseferry Road, Limehouse, London, but the cost of transportation would have left only a very small profit to the city. It used to be considered worth while to recover solder from old tins, but with the marked increase in the use of molded tinware the amount of solder recoverable has diminished to such an extent as to make its recovery commercially impracticable.

To operate the destructor, six men, including a foreman, are employed on each of the two shifts. The ten men are paid 34 shillings and the two foremen 36 shillings per week of six days, which is the union rate, and is equal to $8.19 and $8.75 per week, respectively. The labor cost of burning the refuse is given as 48.6 cts. per long ton. Assuming 2½ cu. yds. per long ton, this is practically the same as the cost of having the refuse barged away. The relative cost of hauling the refuse to the destructor and to the barges I did not ascertain, but I did learn that the manager of the destructor is quite willing to send as much refuse as possible down the river.

I observed no indications of nuisance of any sort in or about the destructor. The chimney top was free from smoke.

THE HIGH-PRESSURE WATER MAIN system for fire protection of the business district in New York City has been approved by the New York Board of Fire Underwriters, with the exception that certain detail changes are recommended in the hydrants, hose and couplings, to make them interchangeable with the present Fire Department apparatus.

*See "John Burns and the Battersea Metropolitan Borough," Engineering News, April 28, 1904.

*I observed small flagstones in many places in England, and I also observed that the small sizes were handy on account of the ease with which the flags could be removed for laying wire ducts beneath the sidewalks.

RESULTS OF TESTS OF COMMON BUILDING BRICK FOR THE BUREAU OF BUILDINGS, NEW YORK CITY.

By Ira H. Woolson.*

In connection with investigative work for the Bureau of Buildings, Borough of Manhattan, on many new composition building materials now appearing on the market in the form of bricks, building blocks, etc., it became desirable to know the strength and other properties of the common clay brick at present used in this city. Diligent search failed to discover any test records which were at all adequate to our needs. In fact, the paucity of information was surprising. A few test records were found in various engineering books, but the data were very incomplete and many of the tests were so ancient that the results were practically valueless. Methods of brick manufacture have changed greatly in the past twenty-five years, and naturally the quality of the product has also changed. The set of tests recorded here was undertaken for the purpose of supplying the much needed information.

The experiments include tests of transverse and crushing strength, also absorption, fire and freezing tests. It is believed that the series is more complete than any that has hitherto been published upon the brick of this vicinity; however, it is recognized that the data are too meager to enable one to draw definite conclusions. They simply give an indication of probable values. At least five times this number of tests should be made upon each kind of brick before final judgment is passed upon its quality.

The samples for test were selected at the building where they were to be used, and much care was exercised to secure average quality stock. Although all the varieties of brick used in the city were not tested, it is believed that those selected fairly represent the machine-molded, soft mud brick now being delivered in the city. Through the courtesy of the Bureau of Buildings the standard specifications adopted by the Bureau are printed in connection with this article. The specifications are based upon the data of these tests, supplemented by such other information as was obtainable.

As a rule, strength tests were made on five bricks of each variety. If the bricks were unevenly burned, showing some "hard" and some "salmon" or "pale" burned bricks among an otherwise average medium burned stock, the selection of five bricks would be made to include one each of the hard and soft-burned classes. If the bricks were badly burned with the result that a large percentage showed fire cracks, or if carelessness in screening the clay was evidenced by occasional large pebbles in the bricks, one of these more or less defective bricks was included in the test lot. In selecting the brick no attention was paid as to where or by whom they were made. Subsequent investigation disclosed that they were all manufactured along the shore of the Hudson River. One set of Philadelphia pressed brick was tested for comparison. The trade-marks which the bricks bore have been omitted from the report for obvious reasons.

The following method of testing was adopted: Five bricks were first tested transversely, producing ten half bricks. Five of these were tested for crushing strength; three others were taken to determine absorption, being afterwards crushed wet. The remaining two half bricks were used for fire tests. Duplicate bricks were used for the balance of the fire test, and for the freezing tests. By this plan the same bricks were used for the different tests so far as possible. A detailed description of the method of conducting each test is given, because such information is often useful to investigators who desire to compare results. Unfortunately, many published test reports lose much value because these data are omitted.

Table I. gives a detailed statement of the results of each test.

TRANSVERSE TEST.—The bricks were supported on well-rounded knife-edge supports 7 ins. apart, care being taken to insure an even bearing on each support, thus avoiding twisting stresses. The load was applied at the middle by a similar rounded edge.

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The modulus of rupture was calculated from the well-known formula $R = \frac{3}{2}\frac{W l}{b h^2}$, and serves to bring the transverse strength to a common standard for comparison, irrespective of variations in size of cross-section.

The results in many cases were much lower than expected, and indicate either that brick have deteriorated in quality or that the figures given in engineering hand-books and text-books are based upon tests of selected stock, in which case they are misleading. With two or three exceptions, the average modulus of rupture was 20 to 50% lower than recorded for common brick in most books. As brick in a wall rarely fail by crushing, but often break crosswise, due to unequal loading, or settlement of foundation, the transverse strength is an important characteristic. The average modulus of rupture for the series exclusive of the Philadelphia brick was 499 lbs. per sq. in.

COMPRESSIVE TESTS.—The half bricks used for this test were faced with a thin layer of plaster to provide an even bedding surface and an adjustable bearing plate in the machine insured uniform loading over the whole surface.

Apparently no intimate relation exists between the transverse and crushing strengths. While in a general way the results of one test may indicate what to except in the other, it is an uncertain guide, for wide variations in one kind of test show no corresponding fluctuations in the other. This same fact was noted by the State Geologist of New Jersey in discussing a large series of tests made by the writer upon the bricks of that State, the report of which was recently published in Volume VI. of the State Geological Survey.

The lack of conformity between the transverse and crushing strength is plainly shown in Table 2. where the top of each heavy parallel line indicates the average compressive strength of five brick of one variety, while the bottom end of the line indicates the average transverse strength of the same five bricks. The apparent absence of relation between the strength and the absorption is also indicated by the irregular curve below the parallel lines, in which the average point of absorption for each variety of brick is plotted immediately under the parallel line representing the strength of the same brick. In studying the comparison, however, it must be remembered that the strength averages were plotted from sets of five, while the absorption tests were made in sets of three. This might make some difference. A much larger number of tests should be made in order to obtain a true index of the relation if any exists.

The effect of crushing the bricks while wet is also shown on the parallel lines by the short cross lines, each cross line indicating one brick. In cases where the strength wet was an increase rather than a decrease, it is shown by a dotted line at the end. The average compressive strength of the present series exclusive of the Philadelphia pressed brick was 3,943 lbs. per sq. in.

ABSORPTION TEST.—Following the line of some experiments made by the writer during the past year upon rapidity of absorption in bricks, the method of getting that value in this instance was as follows:

Three samples of each variety of brick were chosen. The samples were all half bricks, thus giving one broken surface. They were first carefully dried at a temperature of about 150° F. to a constant weight. This usually took four or five days. Two of the bricks were then immersed in water and the third was placed with one face only in contact with the water to a depth of ⅛-in.

Weighings were made and absorption calculated by weight at 30 minutes, 4 hours, 1 day, 2 days and 5 days. The results are very interesting. As a rule over 90% of the total absorption took place during the first 30 minutes. In four hours the absorption was nearly complete. The average increase from two days to five days was less than ½ of 1%, thus showing the latter limit to be unnecessary for comparative work. It is surprising to note that in the majority of cases the bricks which had one face only in contact with the water had a higher percentage of absorption in 30 minutes than those of the same variety which were fully immersed. This advantage once gained was maintained throughout.

From the experience of a large number of comparative tests, it is the writer's opinion that this is the correct way to make absorption tests. The water is drawn up into the specimen by capillary attraction and drives the air out, thus giving a more perfect saturation than is obtained by placing the specimen under water. It also approaches more nearly the condition of a brick in the face of a wall exposed to a rainstorm. Some investigators are arguing that the only proper way to make an absorption test upon this material is first to exhaust the air by vacuum pump. It would undoubtedly give a higher percentage, but would it be a fair result? The writer objects to that method as introducing unnatural and forced conditions which could never actually exist in practice. It is extremely doubtful if air which is so thoroughly occluded in a brick that it requires a vacuum pump to remove it would ever come out when that brick is built into a wall.

It is important that a brick be first dried to a *constant weight*, then if placed with one face in contact with water for 48 hours it is pretty certain to absorb about as much water as would ever get into it under natural conditions. Long continued contact with water will increase the absorption a little, but not enough to make it worth while to continue the test over 48 hours. The rate of absorption is important, and is obtained by weighing at short intervals in the beginning of the test. No study was made of the effect of varying the depth the single face was immersed, but it probably would make little difference up to one-third the height of the brick.

Whether this method would prove equally satisfactory when applied to a dense brick like a paving brick was not determined. It is quite likely they would require deeper immersion.

There is another very decided advantage gained by wetting one side only. If a brick has any tendency to stain or effloresce this method will bring it out. If a stain is likely to occur it will probably appear before complete absorption has taken place. The water will drive it out at the top. Efflorescence may also appear in the same way while the brick is wet, but ordinarily not. However, if there is any tendency to produce this discoloration, it will promptly appear when the brick begins to dry after the absorption test is finished. It will be noted that the New York Building Bureau has adopted this method of test in its standard specifications.

Immediately after the specimens had been weighed for the five days of absorption, they were faced with plaster and crushed to ascertain the effect of saturation upon the strength; comparison being made with the other half of the same brick tested in its normal condition. Over 70% of the bricks showed a decrease in strength varying from 10 to 45%. The remainder reversed the proposition and gave an increase rather than a decrease in strength.

The reason for this is uncertain, but probably may be attributed to the well-known fact that owing to presence of pebbles, small cavities or imperfect burning, one-half of a common clay brick is often much stronger than the other half. This is the only explanation which would account for the erratic results obtained. One column of the table is devoted to the percentage loss, due to crushing wet, but when there was a gain it is indicated by an interrogation mark (?), no calculation being made.

FIRE TESTS.—The fire test was applied merely to ascertain the relative resistance of each variety of brick to heat. The method used was adopted simply because it was a convenient way to get relative results. Whether it is the best method for a laboratory test is undetermined, but it served the purpose intended. Possibly it is too severe. Without doubt the correct way to test brick by fire is to build a wall in a test house and then test it like a partition.

Two half brick of each variety were placed in a cold gas oven and so arranged that the flames could play about them, but the sharp jets of blue flame could not strike them. The heat was raised very gradually, a temperature of 800° F. being obtained in half an hour, and 1,700° F. (about the heat of a burning building) in 50 minutes. This

heat was then maintained for 10 minutes. A maximum of 1,750° F. was recorded. At the expiration of one hour one brick of each kind was removed and immediately placed under a strong jet of cold water. The duplicates were allowed to cool slowly in the furnace. As a rule, the bricks subjected to water showed the worse punishment, but there were exceptions. Nearly all of them were perceptibly weakened. A second test was made in the same manner, except that the maximum temperature attained was 1,300° F. The effects were the same in kind but little less in degree, as may be seen by inspection of the table. It is evident that bricks of this character cannot be heated to dull redness without danger of being ruined. A peculiar fact only explainable by variation in quality of samples is that the specimens heated to a bright red heat were generally in better condition than those heated to a dull redness.

Tests on two or three lots are missing in the fire and freezing series, because enough bricks were not secured at first, and later they could not be found. Many piles were covered deep with ice and snow.

FREEZING TESTS.—Two half bricks from each lot were taken for this test. They were first soaked for a week, then placed in a refrigeration room and allowed to freeze, after which they were thoroughly thawed in water at about 120° F. The thawing occupied about 40 minutes. They were then put back in the freezing room. This alternate freezing and thawing was repeated 20 times. The period of freezing usually occupied 23 hours, but occasionally 47 hours were taken. The temperature ranged from 4° to 16° F.

The results of the test were not very satisfactory. Only one brick was really ruined by the test, and it had an open shelly structure. A few of the others developed cracks, but the larger part showed no apparent deterioration.

Sand-lime and cement materials tested in the same way have given data equally favorable to the brick. Some experiments are being made to ascertain if a greater number of freezings will break down the specimens.

The writer's results on this test are not in accord with those reported by Prof. Marston in Engineering News for April 21, 1904, and further supplemented by recent letters. Prof. Marston is usually able to disintegrate any brick in 3 to 15 freezings at temparatures slightly above zero. His work is all done on 1 in. cubes cut from the bricks, and this may account in part for the variation in results. Perhaps there is also a difference in quality of material tested. The writer is strongly of the opinion that whole or half bricks should be tested, preferably the latter, because they expose the interior to action of water and frost.

If 1 in. cubes are cut from a brick, it is likely to cut the bonds of the material and the tested portion will not offer the resistance of the original condition. This is particularly true in clay bricks where a distinct lamination is often shown in a fractured surface. Of course it is

TABLE I.

REPORT OF TESTS UPON COMMON CLAY BRICK

Tested by Ira H. Woolson, E.M.

December, 1904

COLUMBIA UNIVERSITY
MECHANICAL ENGINEERING DEPARTMENT
TESTING LABORATORY

Made at the request of
THE BUREAU OF BUILDINGS,
BOROUGH OF MANHATTAN, N.Y. CITY

STRENGTH TESTS.

No. of Series.	Test Number	Character: Burn	Character: Grain	Character: at Fracture	Breaking Load.	Modulus of Rupture	Remarks	Compressive Strength Lbs. per Sq. In.	Per Cent Absorption: 30 Minutes	4 Hours	1 Day	2 Days	5 Days	Compressive Area per Cent of Reduction Due to Compressive Strength
Series No. 1.	1-1	medium	fine		1140	779	½" pebble in fracture	5341						
	2	pale	"	Solid	690	389		4038	19.1	19.2		19.5	19.7	143.11%
	3	medium	"	"	1370	846		3415	10.2	10.5		11.1	11.2	2233 340
	4	partly "	"	"	1480	923		4393	6.8*	12.4*	12.6	13.6	13.7	3136 28.1
	5	pale	"	"	1660	992		5243						8*
				AVERAGE	786		AVERAGE	4346			AVERAGES	12.9		31.0
Series No. 2.	1-2	medium	fine	Solid	620	381		5280						
	2	"	"	"	840	520		4783						
	3	"	"	"	750	439		4800	13.9	13.3		13.8	14.0	4377 88
	4	"	"	"	730	453		4857	12.1	12.9		12.9	13.1	4398 39
	5	hard	"	"	670	389		6420	7.6*	14.4*	14.6	14.7	14.9	4110 36.0
				AVERAGE	735	455	AVERAGE	5168			AVERAGES	14.0		16.1
Series No. 3.	1-3	pale	fine	Shelly	810	489	few small pebbles in fracture	1607	19.0	19.5		20.0	20.1	1905 ?
	2	"		Shelly	610	367	irregular long fracture	2787						
	3	medium	fine	Solid	620	390		3129	12.0	12.5		13.4	14.0	4212 179
	4	pale	fine	"	520	309		2436						
	5	medium	"	"	510	306		3379	19.7	20.5	20.9	21.0	21.4	2640 24.3
				AVERAGE	570	372	AVERAGE	3108			AVERAGES	18.5		22.0
Series No. 4.	1-4	medium	fine	Solid	660	442		4748	13.8	14.0		14.8	13.1	3040 38.9
	2	pale	"	"	570	373		3971						
	3	medium	"	"	580	396		4780						
	4	"	"	"	700	444	fine crack in center	5600	14.6*	13.4*	13.6	13.7	14.0	2833 49.3
	5	hard	"	Solid	410	279	dark center	6236	7.9	8.4		9.2	9.6	4046 24.2
				AVERAGE	587		AVERAGE	4873			AVERAGES	12.6		40.6
Series No. 5.	1-5	pale	fine	Solid	650	401		2356	17.6	18.0		18.3	19.1	2436 ?
	2	hard	"	"	400	230	dark center - some small fire cracks	4895	"					
	3	pale	"	very yellow	750	412		3611	9.9	13.1	13.5	13.7	14.0	3640 ?
	4	hard	"	"	730	471	any dark center irregular break off center	5310	6.7	7.3		8.2	8.7	
	5	medium	fine		870	491	broke off center	4830						
				AVERAGE	680	401	AVERAGE	4180			AVERAGES	13.9		
Series No. 6.	6	pale	fine		210	135	½" pebble in fracture	2466	18.9	19.9		20.6	21.0	2478 ?
	2	medium		medium brown	740	469	few small pebbles	4246	19.9	18.4		16.0	17.1	2784 297
	3	"	fine		500	311	⅛" pebble in fracture	3680						
	4	"	"		730	478	⅛" " "	4359	17.7	18.8	19.0	19.1	19.3	2443 48.6
				AVERAGE	548		AVERAGE	3788			AVERAGES	19.1		39.1
Series No. 7.	1-7	medium	fine	Solid	1300	749		2229	12.6	13.4		14.4	14.8	2863 ?
	2	"	"		480	286	diagonal break	3306	11.2	11.6		12.2	12.6	4511 ?
	3	"	"		1080	649	" " ½" pebble in fracture	2240	10.3*	11.5*	11.8	11.9	12.3*	4800 ?
	4	"	"		500	291	Two " pebbles "	5753						
				AVERAGE	840		AVERAGE	3487			AVERAGES	13.2		
Series No. 8.	1-8	medium		Shelly cracks	880	532		2312	10.3	10.6		11.0	11.0	1812 21.6
	2	"		Solid	870	550	fine gravel in fracture	3633	16.8	17.3		17.8	18.3	2575 31.4
	3	pale			400	248	mixed " "	1932	17.4	17.6		18.1	18.3	2030 ?
	4	medium			600	368	Two ½" pebbles " "	2467	13.3	13.6		14.1	14.6	3203 ?
	5	"	fine		980	582		2890	17.3	17.7		18.1	18.6	2824 4.3
	6	"	fairly fine		970	611		2730	13.3	13.6		14.0	14.4	1777 21.4
				AVERAGE	783		AVERAGE	2701			AVERAGES	14.2		33.2
Series No. 9.	1-9	medium	fine	Solid	860	492		4882	13.8	14.2		14.9	15.5	
	2	"	fairly fine		240	180	several pebbles and 1½" clay nodule in frac	2720	18.1	19.1	19.2	19.3	19.5	3042 ?
	3	"			590	362		2395	16.5	16.9		17.2	17.5	1718 28.3
	4	pale	"	"	400	297	crack visible before testing, pebbles in fracture	2443						
	5	medium	fine		370	243		2326						
				AVERAGE	503		AVERAGE	2939			AVERAGES	17.5		28.2
Series No. 10.	1-10	medium	fine	Solid	1100	633		5326	12.6	13.1		13.8	14.0	3780 35.1
	2	"			1110	777	black center	5302						
	3	"	fine		1220	805		5410	14.9	15.0	15.2	15.2	15.4	3733 30.6
	4	hard	"		330	212	Crack at center before testing	5908	11.1	11.5		13.0	12.6	3530 6.0
	5	medium	"		1010	1010		5183						
				AVERAGE	796		AVERAGE	5426			AVERAGES	14.0		23.9
Series No. 11.	1-11	medium	fine		800	474		2731	15.1	15.7	15.8	15.9	16.2	2723 11
	2	"	"		990	633		5270	17.6	17.9		18.1	18.4	3143 31.4
	3	"	"		870	570	fogged and diagonal fracture	3944						
	4	pale	"		1010	686		4038						
	5	"	"		730	441		3946	14.7	15.2		15.6	16.0	2742 7.3
				AVERAGE	880	535	AVERAGE	4786			AVERAGES	15.5		9.9
Series No. 12.	1-12	medium	fine Shelly		640	373	numerous pebbles in fracture	2800						
	2	hard	medium fine		850	503	dark center	2396	7.5	7.6		8.8	8.9	1732 27.7
	3	medium	pale fine Shelly		400	250	1 stone and numerous pebbles in frac	2080	11.9*	12.6*	13.1*	13.4*	13.6*	1141* 40.1
	4	"	medium fine Shelly		800	464	Slightly shelly center	3617	13.2	13.4		12.9	14.0	3260 31.6
	5	hard	" "		690	423	diagonal fracture	2694						
				AVERAGE	663	403	AVERAGE	2717			AVERAGES	12.2		36.8
Series No. 13.	1-13	medium	fine	Solid	1170	645		3891	16.9*	18.7*	18.8*	19.0*	2584	33.6 4
	2	"	"	"	1440	798		3619	17.1	17.5	17.8	18.0	2934	18.4
	3	"	"	"	1530	863		4464	16.3	16.5	16.9	17.1	2619	41.4 5
	4	pale	"	"	1100	607		2713						
	5	medium	"	"	990	535		4065						
				AVERAGE	1246	689	AVERAGE	3750			AVERAGES	18.0		31.1
Series No. 14.	1-14	medium	fine	Solid	1050	675		4488	16.7*	16.8*	16.9*	17.0*	3633	19.2 2
	2	med hard		Solid	1010	638	Large percentage fine gravel in fracture	2744						3
	3	medium			950	626	¼" gravel in fracture	3483		14.9	15.0	15.4	15.6	4454 ?
	4	med hard		Solid	1300	884	large percentage fine gravel in fracture	3728		10.2	10.8	11.1	11.4	3393 3.9
	5	Hard		Shelly cracks	530	360	" " " "	3714						
				AVERAGE	1168	642	AVERAGE	4040			AVERAGES	14.7		11.5
TOTAL AVERAGES			MOD. OF RUPTURE		499		COMPRESSIVE STRENGTH	3943		% ABSORPTION		15.3		
Series No. 15.	1-15	medium	fine Salmon		2860	1391		8286	6.8	6.9	7.0		7.3	7944 41
	2	"	" "		3100	1320		9425	5.0	5.2	5.6		5.8	7680 18.5
	3	"	" "		1830	941		5293	10.0	10.3	10.7		11.2	5660 ?
	4				300	137	Broke in a flaw due to large fire crack	4997	11.1*	11.4*	11.6		12.2	5414 ?
	5				1050	476	Bldg due to pebbles and small " cracks	3524	11.9	11.7	11.9		12.4	2913 13.3
	6				1990	957		6637						
				AVERAGE	983		No 4 omitted AVERAGE	6761			AVERAGES	9.8		12.6

FIRE TESTS

Number	Heated to 1750° F. Equal to a Bright Red Heat	Heated to 1300° F. Equal to a Dull Red Heat
1	Hair line cracks in all directions - broken under hand pressure.	
2*	Good condition - no cracks	Sound - good condition
3		" " "
4*		
1	Hair line cracks in all directions - broken under hand pressure	
2*	One crack half way across, otherwise in good condition	
3		
4		
1	Hair line cracks in all directions - broken under hand pressure	
2	Few hair line cracks - broken under hand pressure	
3*	Good condition - No cracks	
4		
5		
6		Hair cracks - easily broken by hand
7*		One or two cracks - otherwise sound
1	Hair line cracks in all directions - broken under hand pressure	
2	Few hair line cracks - broken under hand pressure	
3*	Good condition - No cracks	
4		
5		
6		
7*		
1	Few hair line cracks - broken under hand pressure	
2*	Good Condition	
3		One hair line crack - broken across wise
4		under hand pressure
5		One crack, broken apart by hand pressure
6*		
1		
2		
3		
4		
5		
6*		
1	Hair-line cracks in all directions - broken under hand pressure	
2		
3		
4		
5		
6		
7		
8		Hair cracks - broken under hand pressure
9		No cracks but weakened at corner
10*		was broken off by hand
1	One hair line crack - broken	
2	Hair line cracks in all directions - broken under hand pressure	
3	No cracks, but weakened - broken under hand pressure	
4		
5*		
6		Hair Cracks - broken under hand pressure
7*		One cross hair crack - easily broken by hand
1	Hair line cracks in all directions - broken under hand pressure	
2		
3		
4	Good condition	
5*		
6		Hair cracks - easily broken by hand
7		One cross hair crack - " " "
1	Hair-line cracks - broken under hand pressure	
2		
3		
4	Good condition	
5		
6		Broke on application of water
7		
8		Two or three cracks, easily broken by hand
9*		
1	Good condition	
2*	" "	
3		
4		
5		
6		
7		
8		
9		
10		
1		Cracked so that it could be broken by hand, but otherwise uninjured
2		
3		
4		
5	Cracked nearly thru in furnace, - fell apart upon application of water. The pieces were easily broken by hand	
6		
7		
8		
9*		
1		Apparently uninjured
2		
3	Two or three hair-line cracks, - could not be broken by hand, - otherwise in good condition	
4		
5		
6	Cracked as if came from furnace and fell apart under effect of water	
7*	Hair line cracks in all directions - broken under hand pressure	
8		Same as #7
9		" " "
10	Cracked in all directions in furnace and fell apart on application of water	

FREEZING TESTS

Number	
1	
2	
3	
4	
5	
6	No apparent effect
7	" " "
1	(Medium hard burn) ½" crack across one edge
2	
3	
4	
5	
6	No apparent effect
7	" " "
1	Numerous small cracks covering bottom, and several on other faces (Not quite hard burned)
2	
3	
4	
5	
6	No apparent effect
7	No apparent effect
1	
2	
3	
4	
5	
6	No apparent effect
7	(Hard burned) Cracking the line of the weight showing tendency to scale
1	
2	
3	
4	
5	
6	No apparent effect
7	(Medium hard burned) Two or three well defined cracks (not weight) probably weakened before freezing
1	
2	
3	
4	
5	
6	No apparent effect
7	One well defined crack and one quarter of cross section. (Medium hard burned)
1	
2	
3	
4	
5	
6	No apparent effect
7	" " "
1	
2	
3	
4	
5	
6	No apparent effect
7	" " "
1	
2	
3	
4	
5	
6	(Medium hard burned) Badly cracked flatwise three bricks, - broken apart by hand pressure
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
1	
2	
3	
4	
5	
6	
7	No apparent effect
8	" " "
9	
10	

FOR COMPLETE DESCRIPTION OF THESE TESTS SEE DETAILED REPORT ACCOMPANYING THIS SHEET.

NOTE - Three readings marked with cross were obtained on samples having only one face in contact with water.

GENERAL REMARKS - All specimens were half brick except #10, series 15, which was whole. Specimens designated with cross thus, 5* were allowed to cool slowly in furnace, - all others were subjected to a stream of cold water on removal from furnace.

NOTE - Specimens were all half brick and were nearly all medium hard burned.

...h cheaper and easier to test a dozen 1-in. ...s than a dozen half bricks if the freezing is ...e by salt and ice mixture. On the other hand, ... would be largely offset by the cost of cutting. ... writer has made a few tests upon one and ...-inch cubes, but the results are not different ... those obtained upon the largest samples.

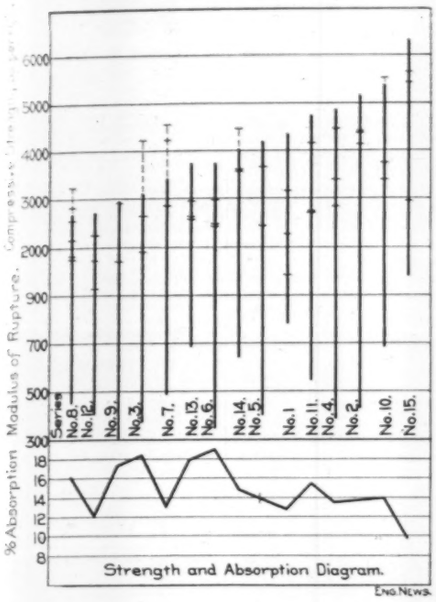


Fig. 1.

The whole question of the method of testing bricks should be brought to a common standard, and it is hoped that the American Society for Testing Materials may be induced to undertake this in the near future. Until this is done it will be impossible to get a proper valuation of a material tested in one laboratory in comparison with similar work done elsewhere.

A NEW GASOLINE ROCK DRILL.

The accompanying photograph shows a machine well worthy of investigation by contractors and mining men. A rock drill, with a portable power plant weighing, all told, only 400 lbs., and requiring not more than 3 gallons of gasoline per 10-hour shift, is a machine for which there should be a large field, provided it drills with reasonable rapidity and costs no more to keep in repair than the ordinary air drill.

As will be seen in the illustration, the general appearance of the drill is much the same as that of the common air or steam drill. The piston is driven by the explosion of gasoline in the cylinder, and two small fly wheels store up power for the return stroke. A hammer blow is struck against the chuck which holds the bit, the cutting bit being constantly in contact with the face of the rock, except on the return of the ram, when the rebound of the steel withdraws the bit from the cutting face a sufficient distance to allow the ratchet to rotate the cutting bit. In other words the cutting bit is not churned back and forth in the hole, but is rotated and struck by a ram very much as a hand drill is struck by a hammer. This appears to be a good feature to prevent sticking of the bit in the hole. The manufacturers state that if a hole shows signs of getting crooked, a drill with sharp corners can be used at any point in the hole, as the drill can be run without striking the rock and can be gradually fed up to ream out the hole.

To remove the rock dust or sludge from the hole, a small flexible air pipe is provided which is inserted in the hole alongside the bit. A jet of air is created by a dashpot entering a recess in the front cylinder head of the drill. In wet holes the air jet forces out the sludge and keeps the hole clean.

The drill weighs 325 lbs., and its length from end of chuck to end of feed crank is 4 ft. 2 ins. The diameter of the cylinder is 4 ins., and the stroke of the piston is 4 ins.

The "power plant" weighs 75 lbs., and consists of a case mounted on a light tripod. Inside this case is a copper can holding 3 gallons of gasoline, and another case holding the battery of six electric cells and spark coil, also the carburettor or mixing valve which converts the gasoline to gas.

For underground work, where ventilation is important, a section of fireproof flexible hose is provided, and carries the exhaust gases from the drill to a 1½-in. pipe leading to the surface. As these gases are under slight pressure, a galvanized iron tubing made with slip joints, and doped with asphalt at the joints, serves to carry away the gases. It also serves to ventilate the mine, for at every stroke the piston draws in 50 cu. ins. of air into the cylinder. It is stated that the drill makes 1,500 strokes per minute, which would mean 43 cu. ft. of air per minute.

A driller and a helper are required to operate the drill and the "power plant." Three gallons of gasoline and the cost of maintenance of the plant and the cost of sharpening the bits form the other principal items of operating cost. The drill can be used exactly like an air or steam drill, mounted on a tripod or on a column.

The ultimate success of this type of drill depends wholly upon the cost of maintenance. It would seem, however, from the success of gasoline motors in other fields where severe requirements must be met, that a gasoline drill can be made to meet the severe service of drilling. Air operated drills, like the Leyner drill, have demonstrated the feasibility of imitating the hand method of drilling by striking a hammer blow upon the "steel," at least for depths of hole up to 8 or 10 ft. However, as the depth of hole increases, the efficiency of this method of delivering a blow to the cutting edge decreases rapidly, and we believe that much greater power will be required in deep holes to secure as satisfactory speed of drilling as is now secured in holes of moderate depth.

A NEW GASOLINE ROCK DRILL.

The manufacturers inform us that as high as 3 ins. per min. have been drilled in the hardest granite, but that half that speed is a fair average. In sandstone 6 ins. per min. can be drilled.

The machine above described is called the "Bull Dog" Rock Drill, and is manufactured by The Gasoline Rock Drill Co., 218 South 4th St., Philadelphia, Pa.

REGULATIONS OF THE BUREAU OF BUILDINGS, BOROUGH OF MANHATTAN, FOR THE TESTING OF NEW MATERIALS OF CONSTRUCTION.

The building code of New York City provides that new structural material of whatever character shall be subjected to such tests to determine its character and quality as the Commissioner of Buildings for the Borough in which the material is to be used shall direct. Recently a new material known as sand-lime brick has come into the market, and as it seems likely that concrete blocks and other forms of artificial stone will also soon be presented for consideration, it was decided to prescribe general requirements and tests in order that the Bureau of Buildings might be assured that such materials were suitable. It was determined by the Bureau to take common brick as a standard; any new material to be acceptable should at least prove equal to common brick. The first step was to establish the quality of common brick by a series of tests of such brick as were sold in the New York market, and Prof. Ira H. Woolson, of Columbia University, was engaged to conduct the necessary tests. Based on these tests, regulations have been formulated by Mr. R. P. Miller, Chief Engineer, Bureau of Buildings, and have been approved by Mr. Isaac A. Hopper, Superintendent of Buildings, Borough of Manhattan, New York City.

The results of the tests made by Prof. Woolson are discussed by him in an article contributed to another column of this issue. The regulations for testing new materials of construction that were based on these results are printed here as follows:

(1) The regulations are to apply to all such new materials as are used in building construction, in the same manner and for the same purposes, as natural stones, brick and concrete are now authorized by the building code.

(2) Before any such material is used in buildings, an application for its use and for a test of the same must be filed with the Superintendent of Buildings. A description of the material and a brief outline of its manufacture must be embodied in the application.

(3) The material must be subjected to the following tests; transverse, compression, absorption, freezing and fire. Additional tests may be called for when, in the judgment of the Superintendent, the same may be necessary. All such tests must be made at some laboratory of recognized standing, under the supervision of the engineer of the Bureau of Buildings. The tests will be made at the expense of the applicant.

(4) The results of the tests, whether satisfactory or not, must be placed on file in the Bureau of Buildings. They shall be open to public inspection, but need not necessarily be published.

(5) For the purposes of the tests, at least 15 samples or test pieces must be provided. Such samples must represent the ordinary commercial product. They may be selected from stock by the Superintendent of Buildings, or his representative, or may be made in his presence, at his discretion. The samples must be approximately 8 ins. long, 4 ins. wide and 2 ins. thick. In cases where the material is made and used in special shapes or forms, full size samples may also be called for and tested in such manner as may be directed by the Superintendent of Buildings, to determine the physical characteristic specified in Regulation 3.

(6) The samples may be tested as soon as desired by the applicant, but in no case later than 60 days after manufacture.

(7) The weight per cubic foot and specific gravity of the material must be determined.

(8) These tests shall be made in series of at least five, except that in the fire tests a series of two (four samples) is sufficient. The transverse tests shall be made first on

full-size samples (8 × 4 × 2 ins.). The resulting half samples are then used for the compression and absorption tests; but in no case must both halves of the same piece be used in either series. Half samples may also be used for the freezing and fire tests under the same restrictions. The remaining samples are kept in reserve, in case unusual flaws or exceptional or abnormal conditions make it necessary to discard certain tests. All the samples must be marked for identification and comparison.

(9) The transverse test shall be made as follows: The sample shall be placed flatwise on two rounded-knife-edge bearings set parallel, 7 ins. apart. A load is then applied on top, midway between the supports, and transmitted through a similar rounded edge, until the sample is ruptured. The modulus of rupture shall then be determined by multiplying the breaking load in pounds by twenty-one (three times the distance between supports in inches), and dividing the result by twice the product of the width (approximately four) in inches, by the square of the depth (approximately two) in inches.

(10) The compression test shall be made as follows: The sample must first be thoroughly dried to a constant weight. It must be carefully measured, then bedded flatwise either in plaster of paris or blotting paper, to secure a uniform bearing in the testing machine, and crushed. The total breaking load is then divided by the area in compression, in square inches.

(11) The absorption test must be made as follows: The sample is first thoroughly dried to a constant weight. The weight must be carefully recorded. It is then placed in a pan or tray of water, immersing it to a depth of not more than ½-in. It is again carefully weighed at the following periods: 30 minutes, 4 hours and 48 hours, respectively, from the time of immersion, being placed in the water in each case as soon as the weight is taken. Its compressive strength, while still wet, is then determined at the end of the 48 hours period, in the manner specified in Regulation 10.

(12) The freezing test is made as follows: The sample is immersed, as described in Regulation 11, for at least four hours, and then weighed. It is then placed in a freezing mixture or a refrigerator, or otherwise subjected to a temperature of less than 15° F., for at least 12 hours. It is then removed and placed in water, where it must remain for at least one hour, the temperature of which is at least 150° F. This operation is repeated 20 times, after which the sample is again weighed while still wet from last thawing. Its crushing strength should then be determined, as called for in Regulation 10.

(13) The fire test must be made as follows: Two samples are placed in a cold gas furnace, in which the temperature is gradually raised to 1700° F. in one hour. One of the samples is then plunged in cold water (about 50 to 60° F.), and results noted. The second sample is permitted to cool gradually in air and the result noted.

(14) The following requirements must be met to secure an acceptance of the materials: The modulus of rupture must average 450, and must not fall below 350 in any case. The ultimate compressive strength must average 3,000 lbs. per sq. in., and must not fall below 2,500 in any case. The percentage of absorption being the weight of water absorbed divided by the weight of the dry sample must not average higher than 15%, and must not exceed 20% in any case. The reduction of compressive strength must not be more than 33⅓%, except when the lower figure is still above 3,000 lbs. per sq. in., the loss in strength may be neglected. The freezing and thawing process must not cause a loss in weight greater than 10%, nor a loss in strength of more than 33⅓%, except that when the lower figure is still above 3,000 lbs. per sq. in., the loss in strength may be neglected. The fire test must not cause the material to disintegrate. (Note.—No great stress will be laid on this last test.)

(15) The approval of any material is given only under the following conditions:

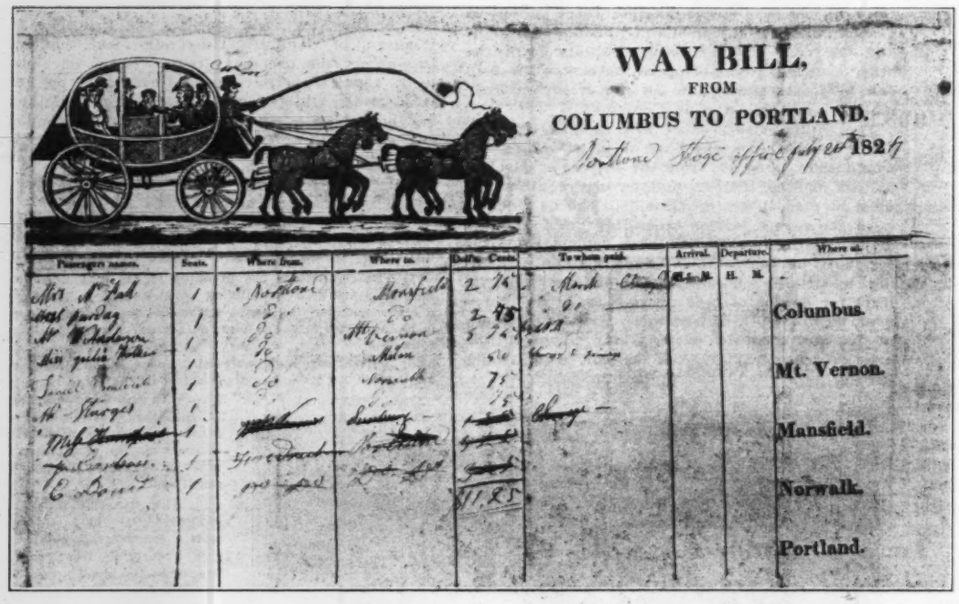
(a) A brand mark for identification must be impressed on, or otherwise attached to the material.

(b) A plant for the production of the material must be in full operation when the official tests are made.

(c) The name of the firm or corporation, and the responsible officers, must be placed on file with the Superintendent of Buildings, and changes in same promptly reported.

(d) The tests must be repeated at any time when called for, on samples selected from the open market, when there is any doubt whether the product is up to the standard of these Regulations.

(e) In case the results of tests made under this condition (d) should show that the standard of these Regulations is not maintained, the approval of this Bureau will be at once suspended or revoked.



A REMINDER OF STAGE-COACH DAYS.

AN OLD-TIME WAY-BILL.

The use of the term "way-bill" in connection with freight shipments by rail is so common that most people at the present day, we venture to say, have forgotten what the original "way-bill" was. The Century Dictionary defines the term as follows:

Way-bill.—A list of the names of passengers who are carried in a public conveyance or the description of goods sent with a common carrier by land.

We venture to say, however, that very few of our readers have ever seen an actual passenger way-bill; and we therefore take space to reproduce an old stage-coach way-bill which was used in Ohio nearly a hundred years ago on a route extending from Columbus north to Lake Erie, about 100 miles. The place called Portland was probably what is now Sandusky. It is of interest to note that the fare from there to Mansfield, a distance of probably about 50 miles, was $2.75, or an average fare per mile of about 5½ cts.

A LIST OF MANUFACTURERS OF CONCRETE BLOCK MAKING MACHINES.

As a matter of interest in connection with our prize offer for papers on concrete block manufacture, we present herewith a list of manufacturers of concrete block making machines, compiled from all available sources. We shall be glad to receive notice of any omissions in this list or of any names included of firms which are not actually engaged in the business of furnishing machines for concrete block manufacture.

American Hydraulic Stone Co., Denver, Colo.
Automatic Building Block Machine Co., Jackson, Mich.
Blakeslee Concrete Block Machine Co., Columbus, O.
Brady Cement Stone Machine Co., Jackson, Mich.
Cement-Normandin Machinery Co., Jackson, Mich.
Cement Machinery & Mfg. Co., Burlington, Ia.
Cement Working Machinery Co., 193 Lafayette Ave., Detroit, Mich.
Century Cement Machine Co., 181 Main St., W. Chester, N. Y.
Coltrin Mfg. Co., Jackson, Mich.
Concrete Construction Co., 3 Broad St., New York City. (Machines for export).
Cottom Artificial Stone & Mfg. Co., Dayton, O.
Drake Standard Machine Co., 300 Jackson Boulevard, Chicago.
K. Dykema & Son, Grand Rapids, Mich.
Z. Fielder & Son, 1017 Broadway, Hannibal, Mo.
H. B. Goodwin, 208 Blake St., Indianapolis, Ind.
Hayden Automatic Block Machine Co., Columbus, O.
Ideal Concrete Machinery Co., South Bend, Ind.
International Concrete Block Machine Co., Minneapolis, Minn.
Iowa Building Block Machine Co., 100 First Nat'l. Bank Bldg., Waterloo, Ia.
L. D. Libby, 238 Second Ave., South Minneapolis.
Michigan Cement Block Machinery Co., Union City, Mich.
Miles (P. B.) Mfg. Co., Jackson, Mich.
Miracle Pressed Stone Co., Minneapolis, Minn.
National Hollow Concrete Machine Co., 921 F St., N. W., Washington, D. C.
Nolan & Layman, 2801 18th Ave., South Minneapolis, Minn.
Harmon S. Palmer Co., 1450 Binney St., Washington, D. C.
Noyes F. Palmer Mfg. Co., 150 Snediker Ave., Brooklyn, N. Y.
The Pettyjohn Co., Terre Haute, Ind.
Scott Mfg. Co., Commonwealth Trust Bldg., St. Louis, Mo.
W. J. Scoutt, 60 West Washington St., Chicago Ill.
E. W. Seamans, Grand Rapids, Mich.
Simplex Mfg. Co., Jackson, Mich.
Standard Stone Co., of America, 140 Nassau St., New York City.
Standard Sand & Machine Co., Cleveland, O. (1509 St. Clair St.)
Stevens Cast Stone Co., 608 Chamber of Commerce, Chicago, Ill.
Stewart Cement Block Machine Co., Waterloo, Ia.
Stringer Machine Co., Jackson, Mich.
Underwood Building Block Machine Co., Columbus, O.
U. S. Cement Shingle Machinery Co., Saginaw, Mich.
Universal Concrete Machine Co., Norfolk, Va.
Variety Machine Mfg. Co., 116-118 First Ave., North Minneapolis, Minn.
Waterloo Automatic Stone Machine Co., Waterloo, Ia.
Winget Concrete Machine Co., Columbus, O.
Winner Concrete Block Machine Co., Minneapolis, Minn.

In addition to the above list, we have the following names of firms producing specialties in concrete molding apparatus:

Concrete Construction Co., Steubenville, O., Manufacturers of Molds for Ornamental Construction.
A. H. Kennedy, Rockport, Ind., Template Puller for Concrete Blocks.
Collapsible Centering Construction Co., Detroit, Mich., Collapsible Centers for Concrete Conduits, or Arches.
L. A. Pratt, Bay City, Mich., Galvanized Iron Flacks for Concrete Fence Posts.
J. A. Mitchell, Goshen, Ind., Concrete Fence Posts.
J. H. Emery, West Bay City, Mich., Cement Brick Machine.

THE RAVELING OF NOVACULITE MACADAM in a street in Springfield, Ill., is mentioned by Mr. Arthur Hay, Engineer of the Park District, in his last annual report. It is stated that part of street was paved with novaculite and that freezing weather came on before it had chance to dry out. During the spring thaws the black "gumbo" mud from unpaved streets on both sides was carried on to the novaculite by wagon wheels and churned up with the surface coat of novaculite until the whole mass was cut into ruts and chuck holes. In the spring, after the roadways had dried out, the mud was scraped off as well as possible, the macadam was picked up and rolled. Mr. Hay says in his report:

It is unfortunate that this pavement extends directly through the black gumbo region, for the mud is so extremely sticky that it exceeds the adhesiveness of the binder used with the novaculite and actually pulls the stones out of their bed in the pavement. The western end of the pavement, which extends into the yellow clay country, gives little trouble by picking up.

It is stated that the only way to avoid the expense of repairs due to the action of the gumbo appears to be to pave the intersecting streets.

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ADVERTISING RATES will be furnished upon application. "Want" and "For Sale" notices (especial rates) see pages 26-27. The pages for new "Want" "Proposal" and "For Sale" advertisements are held open until Wednesday noon.

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We print in this issue the report of a Board of expert engineers on the causes which brought about, some weeks ago, the fall of several nearly-completed buildings in New York City. It will be seen from this report that the failures were due to grossly defective construction. The sudden change in the weather, from a continuous temperature below freezing to a summer warmth which quickly thawed out mortar that had frozen before it set, was doubtless the immediate reason why such a number of buildings collapsed almost simultaneously; but while these structures might have stood up if the mortar had had time to set, the Board's report leaves no doubt that the slovenly mason work and poor mortar in the foundation walls ought to have condemned the buildings if they had not collapsed.

Ever since these buildings fell, there has been an outburst of public criticism of the New York Building Department. The newspapers have well-nigh forgotten the responsibility of the owners and the contractors in their eagerness to show that the Building Department was at fault.

At the time of the collapse of the Darlington Building, a year or more ago, we expressed in these columns the emphatic opinion that the primary responsibility for such failures did not lie with the Building Department. We then said, and still maintain, that it is not the city's business to supervise every part of the work of building construction, and that the responsibility for proper supervision lies with the owner. The prevalent idea that in ordinary building construction the owner can simply employ some one to draw plans, let a contract to the lowest bidder and rely upon the Building Department to see that the construction is carried out in a safe and workmanlike manner, is inherently and radically wrong.

We are greatly pleased to see that the Board of expert engineers does not join at all in the current criticism of the Building Department. The Board says plainly that good and safe building construction can only be secured by having competent and honest contractors execute the work under the supervision of competent and honest architects and engineers.

Engineers and architects know well that when a tricky, dishonest contractor is doing work, it is almost or quite impossible, even with an efficient force of incorruptible inspectors constantly on watch, to make sure that there is no scamping at any point.

The owner, however, too often lets a contract to builders of whose reputation he knows nothing, and who have the strong motive of self interest to increase their profits by doing work in the cheapest possible way, and no check is put upon them, save the occasional visits of a city building inspector, who has to look after construction in progress on thirty or forty buildings at the same time.

We risk nothing in saying that Municipal Building Departments as at present organized, cannot prevent such bad construction work as that which caused the recent building failures in New York. In order to absolutely prevent such bad work, cities would have to furnish the same amount and kind of supervision that would be given by a competent architect or engineer to work under their charge. It is needless to say that no city anywhere has ever undertaken building inspection on such a scale.

Turning now to the remedies proposed by the Board to prevent unsafe building construction, it will be seen that they look to one end: Compelling the owner to award the contract to reputable and responsible contractors only, and to provide and pay for competent supervision of construction. The Board would license architects and contractors for structural and mason work, and would compel the owner to employ an architect to supervise the work as well as to draw the plans.

It may be objected to such a system that it would open a door for political favoritism and abuses; but the rejoinder is that the opportunity would be no larger than that which now exists. Dishonest administration can render ineffective any law or system, no matter how carefully framed. The Board of Experts report is to be commended in that it places the responsibility for safe building where it properly belongs; and that it provides a method whereby, under honest administration, the incompetent and dishonest architects and builders can be forced out of business.

A feature of some note in connection with these building collapses in New York is that almost at the same time similar collapses were reported in many other cities. In fact, we do not recall for a long time such an epidemic of building failures as was reported during the month of March. Some of these failures were undoubtedly due to causes similar to those which produced the collapses in New York. Others, while ascribed to quite different causes in the newspaper reports, were doubtless influenced by the weather conditions at a time when a thaw succeeds a long period of freezing weather. A list, which is doubtless far from complete, shows nearly 20 building collapses reported in five weeks, of which the following appear to have been due to causes similar to those of the New York failures:

March 9, a 3-story brick factory building under construction in Reading, Pa., failed in part. According to press reports the foundation yielded and the walls bulged.

March 18. A store building at Dickson, Tenn., "crushed its foundations" and collapsed. Charged to excessive weight on the floors.

March 19. A 5-story factory building at Morris, Ill., collapsed. The building was comparatively new. The lower floors appeared to fail first.

March 28. At Detroit, Mich., a 2-story flat house under construction fell. Brick veneer building nearly completed. Foundation wall 12 ins. thick failed.

None of these four accidents appears to be chargeable to weakening by old age, abuse or similar causes. The design or the execution, or both, are indicated as responsible. The foundation appears to have been the point of weakness in all the cases.

Of the other accidents in the list, several are cases of old buildings, past their useful life, overcome by the attack of Spring. Others are the effects of overloading floors, combined in some cases by decay of the supporting timbers. Still others are the results of careless work in undertaking repairs or in carrying on adjacent construction. A few belong in none of these classes, but indicate a fault in the design or the construction, though the failure occurs many years after the structure was built. A building wall in Pittsburg, Pa., fell on March 26, because "recent rains had weakened the wall"; it is said to have been known to be unsafe. A retaining wall at Newark, N. J., gave way on April 4, "because of recent thaws." One wall of a school building at Bridgeton, Mo., long considered unsafe, collapsed on March 17, fortunately before the scholars assembled in the morning.

The movement for municipal ownership of the street railways of Chicago has been growing steadily for some years, assisted largely by the dubious financiering and poor service which have marked the management by corporations. This movement seems now to have entered upon a period of unusual activity, as the new mayor, Mr. E. F. Dunne, was elected April 4 on the platform of "immediate municipal ownership," as opposed to the plain "municipal ownership" platform of the defeated candidate, Mr. Harlan. As an extremely involved and complicated controversy between the city and the street railway companies is now in the courts, and as the city council is more conservative in the matter than the new mayor, it remains to be seen what can be done to hasten the acquisition of the railways by the city. The city of Glasgow, Scotland, which has owned and operated its street railways for some years, has been taken as the highest example of municipal ownership, and immediately upon his election, Mr. Dunne sent a cable message to the mayor of Glasgow, asking him to send his "traction expert" to Chicago for a month to investigate and report upon methods of management, etc. This request has been granted, and the manager of the Glasgow city lines, Mr. James Dalrymple, will make his visit next month. The city of Chicago has certainly taken an important step, and the progress of negotiations between the city and the companies will be watched with interest.

The tests of common building brick which are described by Prof. Ira H. Woolson in another column of this issue, deserve the careful attention of engineers. Despite the extensive use of this material and the apparent mass of information that has been accumulated concerning it, engineers who have had occasion to make the search, are confronted with the fact that there are almost no reliable data of its strength and durability. In the tests recorded by Prof. Woolson, the Bureau of Buildings of Manhattan Borough, New York city, has undertaken to remedy this deficiency. The result of the effort is decidedly interesting. While so limited a series of tests cannot be claimed to establish definite final conclusions of general application, it certainly has given in the results obtained sufficient proof that we need to revise our data on the physical characteristics of common brick. One of the first things that Prof. Woolson finds is that the figures of transverse strength given in engineering books are too high; his tests show results from 20 to 50 per cent. lower than the figures given in the text books. Going further, the results obtained by Prof Woolson indicate that there is no conformity between transverse and crushing strengths, or between strength and absorption. The tests indicate also that common brick of good average stock will give an ultimate compressive strength of nearly 4,000 lbs. per sq. in. They show further that this strength is generally reduced by the absorption of water by the brick; over 70 per cent. of the brick tested wet showed a decrease in strength varying from 10 to 45 per cent. A notable fact brought out by the absorption tests is that the bulk of the water absorbed is taken in within the first half-hour of immersion, and that after 48 hours the amount of water absorbed is very small, less than 1 per cent. of the total absorption. Another interesting detail of these tests is that the absorption is always as great and sometimes is greater, when the brick is only partly submerged. On this showing Prof. Woolson recommends only partial immersion in making absorption tests, arguing that this represents more closely than does complete immersion the actual conditions of a rain wetted wall, and also that it makes possible a study of the tendency of the brick to stain or effloresce. The results of the fire and the freezing and thawing tests are inconclusive, and, as Prof Woolson points out, are open to criticism in some par-

ticulars. They show certainly that the common building brick is a remarkably resistant material, even under the most severe attacks of heat and cold. In conclusion we commend Prof. Woolson's concluding suggestion that the whole method of testing bricks should be standardized.

As the result of these tests conducted by Prof. Woolson, the Bureau of Buildings of Manhattan Borough, New York city, has promulgated a set of specifications for determining by test the suitability for use in New York of sand-lime brick, concrete blocks and artificial stone products of various kinds. This is, we believe, almost the first, if not the very first, attempt of an American municipality to give officially these new materials a recognized standing and place among building materials. There is no question but that sand-lime brick and concrete blocks will in the future be extensively used in certain classes of building work. At present there is no standard by which their suitability and efficiency can be judged, and both the manufacturers and the possible users are suffering because of these facts. Whether or not the standard tests which have been formulated by the New York Bureau of Buildings are just and reliable in all particulars must, of course, be determined by experience, but they at least give us a basis of comparison which is much needed, and for this the Bureau deserves credit.

BRITISH REFUSE DESTRUCTORS AND AMERICAN GARBAGE FURNACES.

In no other branch of the municipal service has Great Britain so far outstripped the United States as in refuse cremation. In all things pertaining to water supply, sewerage, paving, street lighting and cleaning our best practice is at least as good as is theirs: Where we fail it is because we do not live up to our knowledge. But in the disposal of garbage and other refuse by cremation our most notable attainments, if conditions in the two countries warrant comparison, are not on a par with the most ordinary and common practice in England, Scotland and Wales.

The British householder throws his garbage, ashes and miscellaneous refuse into a common "dust bin" or other receptacle, from which the mixture is taken to a destructor equipped with forced blast, steam boilers, economizers, superheaters and all known modern devices for producing complete combustion and high temperatures and for utilizing every possible heat unit before the flue gases reach the chimney. The residue from the mixed refuse is a highly vitrified clinker and a very small amount of fine ash and flue dust. The clinker is crushed and used for sewage filters, road foundations, concrete or, in the finer sizes, and sometimes combined with fine ash, for builder's mortar. The steam generated in the destructor boilers is supplied to electric light and power stations or is used to pump sewage or water; and whatever else is done or not done with it the steam is invariably used for "works purposes," such as driving clinker crushers and mortar mills. The steam is also used to produce forced blast, either directly through steam jets or indirectly by driving fans for air blast.

Mixed refuse is found throughtout Great Britain whether destructors are used or not. Where destructors are not used the refuse is "tipped" on land or carried to sea, reduction, or the recovery of grease and fertilizing material from kitchen garbage, being unknown in England and Scotland.

In the United States most of the larger cities which dispose of their refuse by any means but dumping on land or in water, contract with private companies for treating the garbage in reduction works. The alternative is cremation, which at one time or another has been practiced in a hundred cities and towns.

Wherever in this country either furnaces or reduction works are employed, with one or two possible exceptions in the case of furnaces, the ashes are excluded from the garbage and are got rid of separately.

In the United States fuel is practically always bought and used to burn garbage; in Great Britain it appears that purchased fuel was rarely used to aid in the combustion of the mixed refuse in the early destructors, and is never used in the modern installations. Many an American garbage furnace has been shut down for months at a time or finally abandoned because of the alleged excessive cost of fuel. British destructors have practically always supplied enough heat from the self-burned refuse to meet all the demands for works purposes and to-day they are supplying many hundreds of horsepower for generating electricity and for pumping sewage and water.

Whence these radical differences? Americans are not backward in developing furnaces and boilers for raising steam from coal, oil and natural gas, and they are credited abroad as well as at home with carrying to a high degree the utilization of many kinds of wastes. Why then do they buy coal to burn municipal wastes instead of using those wastes to save coal? Or dropping for the moment all thought of utilizing or saving anything, why have so many American garbage furnaces failed sanitarily or at best given poor results?

Various reasons have been given for the poor sanitary and economic results shown by American furnaces. In attempting to find a fundamental reason perhaps the most common assumption has been that we fail because we have more garbage per capita, and wetter garbage, too, than do British municipalities, notwithstanding which we throw away vast quantities of unburned coal in our ashes which might be utilized to burn our garbage. It is held by good engineers on both sides of the Atlantic that if we mixed our garbage, ashes and other combustible refuse the resultant would have as high a calorific value and be as easily burned as is the British refuse. Unfortunately readily comparable figures of the composition of American and British refuse are meager; too meager, we fear, to be a safe basis for definite conclusions of general application. Undoubtedly there are large quantities of unburned coal in the ashes of American cities, but it must be remembered that throughout a large part of the country the low winter temperatures make necessary the burning of large quantities of coal, mostly in closed stoves and furnaces, the best of which leave relatively small proportions of unburned coal. The result is a far larger volume of ashes per capita than in England, where open fireplaces are the rule, and where house temperatures are in the vicinity of 60° F., instead of our 70° F.

Assuming that our ashes contain large amounts of coal, we must consider the cost of hauling such large volumes to garbage furnaces compared with the cost of laying down coal by rail or water. We must remember also that many of the British cities are built on relatively small areas, and that British refuse destructors are often centrally located, whereas many American cities are sprawled over large areas, and so great is the prejudice here against any kind of garbage disposal works that our furnaces are forced into the outskirts, requiring long hauls to reach them, the last portion of which is likely to be over poor roads. Relatively short hauls suffice for our ashes, so long as they are unmixed with garbage. As a matter of fact, however, our smaller cities make no attempt to collect ashes. In such cases ash collection and haulage, if done for the sake of the fuel value of the ashes, would be a heavy debit charge against the furnace.

In winter our northern cities would have an enormous volume of ashes and but little garbage, little both as compared with the ashes and with the summer garbage. In summer the proportions would be reversed. In fact, where gas ranges are widely used, as they are coming to be in most cities during the summer months, there are few ashes in summer and large quantities of garbage; large because no wastes can be burned in gas ranges and because of our heavy consumption of green stuff in the summer, some of which, like green corn and watermelons, is practically unknown in Great Britain.

There is no question in our minds but that mixed refuse has contributed very materially to the development of the British refuse d[illegible]tor, with its high temperatures and its utili[illegible] of heat from wastes alone. While we doub[illegible]os-sibility of developing just such destruc[illegible]ere without mixing ashes with garbage, we [illegible]feel that more American data are needed bef[illegible] can be safely concluded that mixed Americ[illegible]fuse can be made to burn itself the year ar[illegible] say nothing of producing power for electrical [illegible]other purposes. There is this to be said, [illegible]ver: Neither mixed refuse or garbage can be [illegible]fac-torily burned without high temperatu[illegible] and once produced why should so much he[illegible] al-lowed to go up the chimney unutilized?

It is a pity that some American city [illegible] not learn just what the self-burning and ste[illegible]rais-ing power of its various classes of refuse is. [illegible] New York and Boston the unsalable portion[illegible] the third separation ((1) garbage, (2) ashes, a[illegible] the other classes of refuse, including paper a[illegible] rags) have been burned for a number of year[illegible] and a little heat has been utilized, but the full [illegible]lue of tailings from these sorting plants has ne[illegible]r been determined. The refuse-burning plant n[illegible] pro-posed in connection with the electric lighting of the Williamsburgh Bridge, as we understand it, will not receive either ashes or garbage.

Whatever might be the advantage of mixed refuse in America, it is certain that its mere substitution for the garbage now burned at so much expense and with too frequent nuisance in American furnaces would not in and of itself raise our furnaces to the high class long occupied by British refuse destructors. Some change in the design of American furnaces is imperative.

Taken as a whole, perhaps the greatest fault in the design of our garbage furnaces has been an arrangement of large grates and feed holes that has resulted in dumping whole wagon loads of coal and very wet green garbage directly onto the fire. Another notable fault has been the lack of division of the garbage grates, on account of which the opening of one stoking door checks the fire in the whole plant. In an attempt to offset these faults, many of the furnaces have been provided with secondary grates on which coal is burned, the gases of combustion passing over the garbage. In strong contrast with these features the typical British destructor has, until recently, been made up of relatively small units or cells, with small grates, back of which are drying hearths which receive the fresh charges of refuse and give it an opportunity to dry and to acquire some heat. The dried and often hot refuse is raked forward as desired onto the single fire provided for each cell, combustion being greatly stimulated by the forced blast already mentioned.

It is not yet generally known in America that a type of British refuse destructors has come to the front within the last few years which resembles the typical American garbage furnace to the extent of having one large grate, but it is important to note that the ashpit space beneath these grates is most carefully divided, with the idea that, in connection with the forced draft, there shall be, in point of cooling the fire during charging or clinkering, a series of small grates, while at the same time giving the benefit of one large fire. There is no drying hearth in some of these furnaces, but neither is there a heavy top feed to dull the fire, as in the American furnaces. Instead, the refuse is hand fed, and is spread with care over the grate so as to check the fire as little as possible.

Charging or feeding, and also stoking, bring to mind the lamentable fact that even could we be assured that our refuse was as easily handled as the British, and even if we had furnaces in all respects as well designed and built as theirs, we should still lack the experienced foremen or managers of the furnaces and the skilled chargers and stokers common abroad. Of what avail to provide the best of furnaces if they are to be turned over to political spoilsmen to operate? But politics and corruption aside, and with the best of intentions as to engaging and retaining men on account of merit alone, how are competent men to be found in a country where none have even been trained to the work? A manufacturer of British refuse destructors has stated that if he were to come here he would try to engage gas works stokers as workmen at his destructor installations, but with

rapid change from coal gas to water gas good stokers are becoming more and more scarce in this country.

inexperienced labor and the likelihood of losing workers by a political upheaval as soon as partly trained are serious obstacles in the development of garbage furnaces or refuse destructors suited to American needs; obstacles, too, that make one hesitate about increasing the bulk of refuse by adding ashes to the garbage.

Nevertheless, we must face the problem, regardless of labor conditions, and try to improve on the design of our furnaces, or soon we shall have nothing but reduction plants, outside of the large and medium-sized cities.

The foregoing remark suggests that while British municipalities and private enterprise have been perfecting refuse destructors, American cities have taken no direct part in the improvement of either furnaces or rduction plants, while most of the private capital and engineering knowledge put into garbage disposal has been swallowed up by reduction systems; and in the latter little of the best engineering or chemical talent of the country has yet gone. Why? Partly because our garbage reduction systems have been so largely mere outgrowths of more or less extensive fat and bone rendering establishments, partly because of the short terms of garbage disposal contracts, which would rarely warrant such outlays as are even now made were it not for powerful political alliances which are believed to ensure renewal without competition, partly because of the bonus from the city, which, again through political influence, is often sufficient to check ambition for improvements in plants which may after all have to be abandoned on account of political reverses, and in general because the reduction companies have had little effective competition among themselves and practically none from the furnaces, and have never had their financial and engineering operations under adequate municipal control.

The conditions affecing the development of American garbage furnaces have been still less favorable than those governing reduction systems. Practically all the furnaces have been built to sell to municipalities, and rarely has there been any adequate engineering supervision by the city or any acceptance test worthy the name. The furnace companies, as a rule, have been too weak to bid with any assurance against reduction companies desiring large contracts, so there has been no stimulus of competition here. Rarely, indeed, has an engineer of any note been engaged by any of the American garbage furnace companies, and such companies as have employed engineers of relatively marked ability have almost invariably held their engineers so severely in check as to dwarf their plans for advance.

It is not a pleasing task to point out these deficiencies in one branch of American municipal engineering and sanitation. It is all the less pleasant, though perhaps somewhat easier, because we have written so often on the unsatisfactory condition of garbage disposal in America. We have never before, however, drawn so many contrasts between American and British conditions. These contrasts have been forced upon us by the recent publication of two notable British books by Mr. W. F. Goodrich, Assoc. Inst. M. E., entitled "The Economic Disposal of Town's Refuse" (1901), and "Refuse Disposal and Power Production" (1904); and also by a visit made by a member of the editorial staff of this journal during 1904 to a number of refuse destructors in Great Britain, to the famous destructor at Hamburg, and the new destructor at Zurich. To a slight extent, only, were the destructors visited selected because of their merit. Instead, they were taken as opportunity afforded during a tour of inspection for other purposes. And yet it may be seen from the notes, the publication of which is begun in this issue, how far different is the current practice in refuse burning abroad and at home. It may well be that not all the foreign conditions are comparable with our own, but certainly they are suggestive. Above all they suggest the necessity of treating garbage and refuse disposal here as it is treated abroad, namely, as an engineering problem.

LETTERS TO THE EDITOR.

A Scale and Card Diagram for Use in Setting Slope Stakes.

Sir: Being much interested in some recent articles in your journal treating of methods of setting out side stakes on slopes, I forward you herewith a sample of the "Civil Engineers' side stake scale," by use of which the work may be performed mechanically, without any calculation, and more accurately than by methods heretofore in use.

The printed directions for the use of the scale are sufficiently explanatory to the intelligent engineer.

It will be seen that the card has an indefinite range, and is decidedly more accurate than the juggling and guesswork now in vogue. The scale card is printed on stiff white cardboard, one-half covered by the scale, and the other half by the printed directions for use, in folder form. The graduated transparent rule, attached or not to the scale card, lies, when not in use between the folds. The folder in this form is supplied with a light rubber band to hold it in an engineer's level book, and can be carried in the pocket with the book.

The application of this scale, I believe, will fill a long-felt want of the craft.

Very respectfully, Thos. D. Ladshaw.

Spartanburg, S. C., March 28, 1905.

The Durability of the Vanes in Steam Turbines.

Sir: The letter appearing in your issue of April 6, relating to the short life of the vanes of steam turbines, deals with a subject of great interest owing to its influence on the prospects of an important and growing American industry.

Whatever the merits of your correspondents' contention may be, there is no doubt that some corrosion takes place, chiefly when the supply of steam is very wet, and when the water is impure and acid, which is often the case. This difficulty can nevertheless be easily overcome by making all the exposed parts of the steam turbines with a steel alloy which will resist the usual oxidizing agencies.

A few years ago I conducted several tests on the influence of sea water on iron and steel, with iron-vanadium and steel-vanadium alloys. Plates and bars of these alloys were immersed for several days in sea water with the result that the vanadium-ferro alloys were found to be perfectly immune. The surface and the fracture of the test pieces were found, at the end of the trial, as bright as on the day on which they were put in the vessel containing sea water; in the comparative tests carried on with bars and plates of non-alloyed iron and steel these were oxidized to a large extent, a sediment of oxide of iron being present in the solution.

Ferro and steel-vanadium alloys can now be produced at a low cost, and its employ for the making of boiler plates and for all the inner parts of turbines and pistons will offer a decided advantage and effect a great saving as compared with any other kind of protective coating. Yours very truly,

J. Baxeres de Alzugaray.

Wall Street Exchange Building, New York, April 10, 1905.

Portland Cement as a Protection of Cast Iron Pipe from Rust.

Sir: In Engineering News of March 23 I note correspondence and editorial comment on the subject of protection of steel from rust with concrete. In the "Proceedings" of the Engineers' Society of Western Pennsylvania, for April, 1904, in the discussion of a paper by the writer on the subject of "Blast Furnace Slag as a Structural Material," you will find a letter from James S. Mack, Superintendent of the Standard Mines, of the H. C. Frick Coke Co., giving his experience with Portland cement as a protection to cast-iron pipe through which they discharge the sulphurous water from that mine. This pipe had been in service seventeen years, and is the best practical evidence of the efficacy of cement for the protection of metal which has come to my notice.

Yours truly, Jos. A. Shinn.

410 Penn Ave., Pittsburg, Pa., March 30, 1905.

(The letter mentioned by our correspondent is as follows.—Ed.)

Sir: Replying to your letter to the 24-in. cast-iron discharge pipe at Standard shaft: This line was put in operation in the spring of 1887. The perpendicular part is 303 ft. deep and the horizontal 130 ft. long. After the lines were in place they were treated with a heavy coating of Portland cement, applied on the perpendicular line with a brush and on the horizontal one with a trowel. Cement had an average thickness where brush was used of ¼-in., and where trowel was used ½-in.

The first break due to service was in May, 1896, when the foot ell burst. It burst or wore out at the curve of the ell. All the cement had been worn off, due to the action of the water in passing around the curve. This left the cast iron exposed to the action of the acid in the water. It was noted at the time of the break that the metal was ½-in. thick at the edge of the hole, which was about 6 × 8 ins. This elbow was replaced and the line next burst on the perpendicular part, about 9 ft. above the foot ell, on Jan. 11, 1899. It showed that water had gotten to the cast iron and weakened the metal so that a piece dropped out 4 ft. long, 2 ins. at the top and 8 ins. at the bottom and ½-in. thick at the edge. With the above exceptions this line has been in continuous service since 1887, and at present an average of 1,400 gallons per minute, day and night, is pumped through it. Yours truly,

Jas. S. Mack, Superintendent.

Field Book Solutions of Railway Location Problems.

Sir: In the "Problem in Railway Location," by Mr. Stowell appearing on p. 206 of your issue of Feb. 23, 1905, the writer quite agrees with Mr. Stowell that the solutions given in field books are impracticable, so much so, that busy engineers do not use them, but resort to graphical methods giving results well within allowable limits of error 99 times out of 100 if the preliminary data are, as they should be, accurate.

It is, therefore, discouraging to have Mr. Stowell discredit his graphical and practicable solution, which, he says, "proved sufficiently accurate for the purpose," and saved time and expense, by a theoretical discussion and solution, which, to the writer, appears to belong to the pocket book class which he condemns.

The writer ventures the opinion that, not once in a thousand times, will a line run on the ground fall precisely tangent to two curves previously fixed, no matter how carefully the preliminary data and theoretical calculations may have been worked out.

The sensible thing to do is to connect the curves by the simplest feasible traverse carefully done and, with equal accuracy, plat the whole layout on a liberal scale, on which the necessary connecting lines and angles can be plotted with the certainty that when laid out on the ground, they will fall well within admissible limits of close approximation and will entirely satisfy every requirement of all ordinary railway location. It is a certainty that one of the curves will finally have to be adjusted to the connecting tangents, no matter how refined and elaborate the theoretical preparation. Every locating party should be equipped with a field outfit for quick and rapid plotting for the problems in question.

Yours truly, J. L. Campbell.

El Paso, Tex., Mar. 29, 1905.

On the Method of Measuring Sewers.

Sir: In regard to the inquiry as to the usual practice in measurement of sewers, Folwell in "Sewerage," Art. 67, p. 256, says:

Measurement of the sewer laid is usually made from center to center of manholes, flush-tanks, etc., not horizontally, but parallel to the sewer.

However, the sewer specifications of the Borough of Richmond contain the following clause:

GENERAL.

Sec. 9. The length of all sewers shall be estimated from horizontal measurement on the center line of the same, and without regard to their gradients, except as otherwise provided herein.

Very truly, E. B. H.

New Brighton, N. Y., April 10, 1905.

Sir: In your issue of April 6, I note a query regarding the method of measuring the length of completed sewers. The general custom in this part of the country is to measure along the center line. Where sewers are build with as much as 20 ft. fall in 100, as is occasionally necessary on our Connecticut hillsides, it makes quite a difference which method of measurement is used, and it seems fair to pay the contractor for the actual amount of sewer he builds. The price we pay per foot of sewer covers all excavation (except rock) as well as building the sewer itself. Our specifications contain the following clause:

The amount of sewer to be paid for shall be equal to the number of lineal feet of said sewer, measured along the center line thereof, from center to center of the manholes constructed under this contract. If no manhole is built hereunder at an end of said sewer, the measurement shall be to the extreme end of the sewer actually built.

Very truly yours,

Henry Robinson Buck,
Ass't. City Engineer.

Hartford, Conn., April 7, 1905.

Sir: It seems rather strange that any question should arise concerning the proper method of measuring sewers for a final estimate. On any ordinary grade it matters little whether the line be measured on a horizontal plane or on the axis of the pipe. I should consider that any contractor who raised the question in making a settlement was looking for trouble.

If the axis of the sewer be taken as the base, the depth of excavation becomes of course the perpendicular to that base instead of the vertical distance from the surface to the sewer. When the contract specifies a scale of prices varying with depth of cut, measurement of that cut on the perpendicular to the axis of the pipe might militate against the contractor by changing the classification and reducing the price per foot. I should much prefer to work under specifications providing horizontal measurements of length and vertical allowances for depth.

From the engineer's standpoint, horizontal measurement is much the better; for it enables him to check his final estimates by his original survey, and to make them agree with the assessments on property frontages without charging against street-crossings a fictitious width.

Some engineers measure sewers on the surface of the street without the rhyme of coincidence with the actual number of feet of pipe laid, or the reasonableness of true geometric theory. I have in mind one case of this kind where the grade was so steep that the road could not be traveled by a vehicle, and the sewers were laid in a series of steps, with deep drop-manholes and short runs between. The sub-engineer in charge of the work estimated surface measurement as the length of the sewer, in addition to allowing contract price per foot for drop in manholes. The contractor was credited with something over 16% more pipe than he had bought or laid. The chief engineer, very properly, revised the estimate.

Very truly yours,

Geo. L. Walker, C. E.

156 Fifth Avenue, New York, April 6, 1905.

Right-Angled Triangles with Sides of Integral Ratios.

Sir: I wish to suggest, for general use among engineers, two simple formulas which are more easily applied to any problem, yet prove the general formula

$$(2n+1)^2 + (2n^2+2n)^2 = (2n^2+2n+1)^2,$$

given by "Copperhill" in your issue of March 9, 1905, for the solution of "Right-Angled Triangles with Sides of Integral Ratios."

In a right triangle, let the hypothenuse be lettered c, and the two sides a and b, as usual. Then:

1. When "a" is an *even* number

$$\text{then } b = \frac{a^2-4}{4}$$

$$\text{and } c = b+2$$

2. When "a" is an *odd* number

$$\text{then } b = \frac{a^2-1}{2}$$

$$\text{and } c = b+1$$

Very truly, J. Calvin Locke.

311 Washington Ave., Brooklyn, New York City, March 25, 1905.

Sir: Several years ago, while engaged on some structural work, the writer had occasion to investigate the subject of right-angled triangles with sides of integral ratios. The solution obtained differs from that given by "Copperhill" in a letter in Engineering News of March 9, 1905, and may be of interest.

PROBLEM.—To find all integral values of a, b, c which will satisfy the equation $a^2 + b^2 = c^2$, a, b and c having no common divisor.

SOLUTION.—Let $c = b + d$; then $a^2 + b^2 = (b + d)^2$ whence

$$b = \frac{a^2}{2d} - \frac{d}{2} \text{ and } c = \frac{a^2}{2d} + \frac{d}{2}.$$

In order that b and c may be integers, a^2 must be divisible by d and $a^2 \div d$ must be even if d be even and odd if d be odd; further, d or 2 d must be a perfect square. If d be a perfect square and even, $\frac{d}{2}$ is even, a^2 must contain 8 as a factor, a must therefore be a multiple of 4, and $a^2/2\,d$ will be even; hence, under these conditions, a, b and c will all be even and divisible by 2; hence, all even squares are eliminated from possible values of d.

If d be a perfect square and odd, $\frac{a^2}{d}$ must be odd and therefore a must be odd. This is always possible and therefore d may be any odd square, say $(2m+1)^2$ where m may be any integer. Let $\frac{a^2}{d} = (2n+1)^2$; then,

$$a = (2n+1)(2m+1),\ b = \tfrac{1}{2}[(2n+1)^2 - (2m+1)^2],$$
$$c = \tfrac{1}{2}[(2n+1)^2 + (2m+1)^2].$$

In the above equations, n and m may be made equal to any integers provided $(2n+1)$ and $(2m+1)$ do not contain a common factor. From the above we find:

$c - a = \tfrac{1}{2}[(2n+1) - (2m+1)]^2 = 2(n-m)^2 = d^1$, hence this case also includes the case where 2 d is a perfect square and therefore includes all possible cases; and it follows that if three integers satisfy the required conditions, the difference between the largest of the integers and one of the others is the square of an odd number, while the difference between the largest and the third is twice the square of some integer.

The table given herewith gives the values of a, b and c for all values of n and m from 0 to 10. It is easily constructed; thus, write the odd numbers in succession in the top row and side columns as shown. The first number in each rectangle is the product of the number at top of column and the number in row at right for rectangles above the diagonal line, and the product of number at bottom of column and at left of row for rectangles below the diagonal line. This is a. The c's are obtained from the a's by adding the same constant in the rectangles on the same diagonal; this constant is 2 for rectangles along a diagonal next to that drawn, 8 in the next, 18 in next, 32 in next, etc., it being

$$2(n-m)^2 \text{ or } \tfrac{1}{2}[(2n+1) - (2m+1)]^2$$

in any case. The b's are then found by subtracting from the c's the square of the number at end of row; thus, the number to be subtracted in the first horizontal row in rectangles on right of diagonal drawn is 1, in the second row 9, in the third row 25, etc., etc., in general it is $(2m+1)^2$.

Or the b and c in any rectangle may be found by taking the squares of the numbers at the end of row and top (or bottom) of column; one-half of the difference of these squares will be b and one-half the sum, c.

By finding the angle whose sine is $a \div c$ or $b \div c$, according as a or b is the smaller, the value of the angle can be placed in each rectangle and then by rearrangmg

1	3	5	7	9	11	13	15	17	19	21	
2	3 4 5	5 12 13	7 24 25	9 40 41	11 60 61	13 84 85	15 112 113	17 144 145	19 180 181	21 219 220	1
21		15 8 17	21 20 29		33 56 65	39 80 89		51 140 149	57 176 185		3
19	399 40 401		35 12 37	45 28 53	55 48 73	65 72 97		85 132 157	95 168 193	105 208 233	5
17	357 76 365	323 36 325		63 16 65	77 36 85	91 60 109	105 88 137	119 120 169	133 156 205		7
15	315 108 333	285 88 295	255 32 257		99 20 101	117 44 125		153 104 185	171 140 221		9
13	273 136 305	247 96 265	221 60 229	195 28 197		143 24 145	165 52 173	187 84 205	209 120 241	231 160 261	11
	21	19	17	15	13	13	15	17	19	21	Even Nos.

according to magnitudes of the angle a table similar to that published in Engineering News of March 9, 1905, is obtained.

Yours truly,

W. H. Schuerman.

Vanderbilt University, Nashville, Tenn., March 16, 1905.

The Fireproof Properties of Concrete and Concrete Building Blocks.

Sir: The results of your proposed competitive discussion of cement or concrete building blocks can hardly fail to prove highly interesting and instructive to your readers, and will especially appeal to those who are studying cement and concrete as fire resistive materials. In your editorial comments you call attention to several interesting points to be considered in discussing cement blocks, but do not mention one very important phase of the question; namely, the fire resistive qualities of the blocks. I trust that prospective competitors will keep this side of the subject in mind.

You very properly call attention to the fact that there has been a superabundance of discussion on the subject of reinforced concrete for various uses; however, in all this mass of literature one of the most important phases of the subject seems to have been omitted. It seems to have been assumed as a matter of fact that concrete is fireproof, and the scientific students have practically confined their investigations to questions of strength and economy of construction. True, those commercially interested in cement or various "systems" of reinforced concrete construction are constantly advertising their work as "fireproof" and are exploiting many tests of their materials (tests of varying degrees of reliability), but there is yet to be produced on scientific lines a series of experiments tending to show the fire resistive properties of concrete as thoroughly and comprehensively as recent tests have demonstrated its other qualities. Naturally the duty of this sort of investigation falls largely on the fire protection engineers to whom you referred in your issue of March 23, and they are now at work on the problem. But it should not be left entirely to them, and I beg to suggest that the engineering societies while discussing so well the numerous other sides of the concrete question should devote some thought to this matter of fire resistance for the reason that the chief claim of concrete to recognition as a building material is that it is supposed to be fireproof.

Yours very truly,

Edward T. Cairns, General Inspector.

North British & Mercantile Insurance Co., Chicago, March 28th, 1905.

(Perhaps engineers are desirous of further data as to the fire-resisting qualities of concrete; but our impression has been that so much data of this sort had already been presented, it was not worth while to take the space to report further tests. If our correspondent, or anyone else interested in this subject, will search through the volumes of Engineering News for ten years past, he will find there reported a large number of tests of fireproof floors of many types, among which are a number of concrete and reinforced concrete. Many of these tests were official tests made by the New York Building Department, and under the direction of engineers of high reputation. Concrete construction has also been exposed to the ordeal of actual fires, and a record of its behavior under such conditions has also appeared in these columns.

So far as walls of concrete blocks are concerned, there is very little on record as to their behavior when exposed to fire. We have to find the item below, however, in a recent issue of "Concrete," which credits it to the Estherville, Iowa, "Enterprise" of Jan. 11, 1905. It is certainly of much interest in connection with the question raised by our correspondent.—Ed.

"In the fire which swept over this city a few months ago the Davis Building, constructed of the two-piece hollow wall system of the American Hydraulic Stone Co. of Denver, Colo., was severely exposed to fire and water, but stood an impregnable barrier to the progress of the flames. There was a solid sheet of flames beating against the cement blocks composing the walls of the building, and then there would be a copious application of cold water from the nozzle. The blocks stood these extremes of temperature without any noticeable splitting or chipping of the blocks.

"The result is a surprise to many; several of the special agents of the insurance companies involved in the fire made a very close inspection of the Davis building in order that they might be able to make an intelligent report to their companies, and one of them, a representative of a London company, said that no ordinary brick wall would have withstood the alternate exposure to heat and cold that these cement blocks did, and another said that on ordinary constructed cement block buildings insurance companies would be warranted in materially reducing the cost of insurance.

"The limestone trimming on the Coon block and the boulders in the foundation were badly split and broken by the heat and water, while the cement blocks were not similarly affected. The inside of the west wall of the Davis building was not in the least discolored by the heat, and at no time was it so hot that one could not hold his hand against it. The strength of the wall is obvious from the fact that the three-story brick wall of the Coon building fell, crushing against it without injurious effect."

The Function of State and National Geological Surveys.

Sir: In your issue of March 16, under the above caption, you have seen fit to criticize the policy, now very commonly prevailing in geological surveys, of discussing technological and engineering matters, and as you have made one of the bulletins of the Geological Survey of Ohio the text for your argument, it is perhaps proper that I should ask the privilege of a reply.

There are two questions involved in your argument: first, whether your conception of the proper sphere of geological surveys in general is a good one, and second, whether your somewhat caustic characterization of the work of this survey in particular is justified by the facts.

Regarding the first point, the burden of your contention seems to be that geological surveys should stick to geology and leave technology and engineering to the private publisher and the technical journal. Here again there are two separate questions involved: First, the actual duty of the geological surveys, as imposed by the laws creating them and the instructions laid upon them from time to time by their respective legislatures. Second, the broader question of whether the public policy now generally in force, by which state and national surveys are required to do such work, is a good one and should be maintained and expanded, or whether it is a bad one and should be abolished as soon as public men can be made to see the error of their ways.

Regarding the first point, I would say that any such sweeping condemnation as was used in this article is not justified when the legal aspects of the case are considered. It would be proper to criticize a geological survey, if it was shown to be exceeding its authority and making investigations and publishing papers upon subjects not provided for in the legislation defining its duties. In some states, the task is sharply limited to the consideration of strictly geological matters. In others, their duties are explicitly made to include technological and engineering work. In others again, the whole field of organic science is added and reports are demanded on botany, natural history, forestry, soil, economics, etc. In such cases, the geological survey becomes, in fact if not in name, a general scientific bureau for the study of all the natural resources of a state and for the means of their proper utilization. In some countries, separate bureaus for the study of technology and engineering are maintained, but in this country the geological surveys are generally the only means of carrying on work of this sort.

In Ohio, the law provides:

It shall be the duty of the State Geologist . . . to study the modes of occurrence and distribution of the useful minerals and the products of these formations; to determine the chemical composition and structure of the same; to investigate the soils and water supply of the state, etc.

Further on it adds that:

he may also collect and describe the fossils of the various formations of the state; but no expenditure shall be incurred under this head that is not expressly ordered and provided for by the general assembly.

In short, the natural resources and their utilization form the prescribed field for our work, while work like stratigraphical and paleontological geology is only permitted under restrictions.

Regarding the second point. It is plain that your attitude is not inspired by the failure of any particular survey to do what it is told to do, but by a general discontent with the conditions which require or permit any geological surveys to invade the field of the technicist or journalist, and thus place scientific treatises free, or at small cost in the reach of the people. In short, you would recommend the use of public funds for the collection and dissemination of knowledge as to the nature and location of mineral wealth, but would refuse them for the equally necessary and important work of explaining their manufacture or use. It is difficult to see the basis for such a distinction, nor does it seem consistent with the attitude shown in your paper elsewhere. For instance, in the same issue (p. 293) you warmly (and justly) praise the report of the coal testing plant at St. Louis, which was done wholly under the supervision of the United States Geological Survey. You call especial attention to the work of the gas producers and briquetting plants and urge every engineer to get a copy of the book.

But, on the theory you have announced, the United States Geological Survey has no business to invade the field of gas making or gas utilization, or the mechanical preparation of fuel for the market. This is technology, pure and simple. It should occupy itself wholly with making maps and studying dip and strata and outcrops—in short with strictly geologic matters.

I can see no difference in the value, or dignity, or importance, or propriety of the two kinds of work. The public needs knowledge in both of these fields and this need is the only excuse for the government's expenditure in furnishing it, and it is an ample excuse.

I hold that the function of government is partly paternal; that it is one of its duties to develop the intelligence and prosperity of the people in every way, just as clearly as in another way it is its duty to exercise police power. To this end, education is fostered from the grade school to the university. The fact that there are private schools or universities does not lessen the obligation of the state to maintain public ones. The fact that there are private laboratories for the investigation of the mineral industries, and private text books, does not lessen the obligation of the state to open an official way for the public to educate itself on matters touching the mineral industry. It is as much within the power and right of the government to stimulate the industrial life of the people by the work of its scientific bureaus, as it is to preserve them from the ravages of disease by the work of its medical bureaus. To be sure, there are always those who cry out against any enforced public precaution, like vaccination, as invasion of their rights, but in this day such people receive rather scant attention.

In Ohio, the work of the earlier surveys has pretty well settled the main features of the geological structure of the state, the composition of the principal rocks, and their geographical location. This may be worked over, by successive generations, with constantly increasing refinements, but after all, in the broad way, the geology of Ohio is now known. What is done hereafter in this line will be of interest chiefly to the student of pure science—the professional geologist—but it will make no great changes in the economic and industrial situation of the people. The work now remaining to be done is technological rather than geological. We know where our mineral resources are. The question now is what can we make of them? Is it not just as logical for the state to help the people to use these resources wisely, as it was to help them to find them?

Taking up at this point the second proposition, viz., your comments on this particular book, I would say that I find myself in accord with your spirit, if I understand it aright. You believe that geological surveys should not publish work which is not in itself good and worthy. You are right in condemning work which has been prepared by people who are not experts in their line and against which valid technical objections can be raised. I think everyone will agree with you on this proposition.

But it does not follow that work to be good must be confined to any one field of geology, or even that it shall always be composed of brand new researches. In short the geological survey is only one of the various branches of the state's educational machinery. Its function is to convey education and information to the people. You assume that it should be only allowed to convey highly technical and specialized information to a limited class of readers, chiefly engineers, and maintain that the application of this information in practice should only be made possible through privately printed books and journals. On the other hand, have the majority of the people who pay for these investigations, no claims for more general and popular statements on the phases of the mineral industry with which they naturally come in contact?

The only proper basis upon which this book can be criticized is in view of the purpose for which it was written. This is set forth in the preface as follows:

> He (the author) has, in accordance with my instructions, made this work a popular one—avoiding the symbols of the chemist or the mathematics of the engineer. He has written to reach the people—the great body on whose increasing intelligence in the use of cements depends the still greater expansion of the industry of the future.

While this bulletin is not the record of new and exhaustive researches in this field, at least to any important degree, and was not intended even to contain a detailed discussion of the many mooted points in theory of cements, it must not be supposed that it is either loose in its statements, or so general as to be of no value. It has been the aim to present the facts, with such few theoretical considerations as are now generally accented, in such a simple and clear manner that it will be understood by all. And this has been done in the belief that in all of the vast literature of the subject no other work yet accomplished gives this simple purpose.

The question is does it fail in this purpose? Your own testimony on this point is clear, for you say it is "well written, more or less interesting and occasionally instructive." If it can receive this commendation from you, it is probably much more satisfactory to the less competent and less critical body for whom it was designed.

Your condemnation of the book as a "scrap book" carries with it the inference that it is to be criticized for quoting matter already published in other books or journals. How else could a book on this subject be written when practically the whole history of the subject is scattered through the pages of the technical press for the last twenty years? Could any one write adequately today on the uses of cement from his own personal experience, without reference to the work of others on almost every page?

While the policy of this survey in publishing books for this purpose may not commend itself to your judgment, after all the only fair test of the book itself is whether its statements are true, its views sound, its scope and conception broad enough for the purpose, and its attitude to existing questions and unproved theories fair and conservative. Can you say that it is not all of these? Do you know of any other work, public or private, which conveys to the novice in the use of cements as much reliable and useful information at the same cost?

The best mode I have of judging whether a bulletin of this survey is fulfilling the purpose for which it was written, is the way it sells. Our exchange list is small, and the law provides that the bulk of the people must secure their copies by purchase. On this basis, people will not get bulletins unless they really want them. The sale of this bulletin in ten weeks has exceeded several times over that of any bulletin issued by myself or my predecessors in this state, for a like period. As the survey does not advertise, and as the book is after all only a "pub. doc." this seems to me to furnish some proof that it is not wholly so worthless as you would have it, and that it does minister to a genuine and legitimate popular need.

One last word: reference to the preface again shows that the book is one of a series, dealing, 1st, with the occurrence of the raw material for the cement industry; 2d, the manufacture of hydraulic cements; and, 3d, the utilization of the hydraulic cements. It was intended that each of these bulletins should supplement the other and thus present to the people of Ohio the whole situation as to this new and rapidly growing industry. The documents were finished in exactly reversed order, and thus the continuity of the series was broken, though the value of the units is not materially affected.

I am entirely willing after this explanation, to leave the public to judge which view of the function of geologic surveys in general and the Ohio Geological Survey in particular, should prevail. And as for the criticism of the book itself, I am entirely willing to let it answer for itself to any one who has seen it.

Very truly yours,
Edward Orton,
State Geologist of Ohio.

Columbus, O., March 18, 1905.

(We are glad to present so able a defense of that part of the work of geological surveys which we recently criticized as outside their proper province. The stronger the defense the more clearly are presented the main points at issue.

Our argument was based, of course, on the theory that the first business of a geological survey is to study and investigate geology, using that term in a broad sense. If a geological survey is intended to be actually a general scientific bureau with liberty to take up any field of investigation with reference to the States' natural resources, it is difficult to say where its activities may not ramify. We have no quarrel with our correspondent in his desire to make the work of his bureau practically useful; but certainly even with the broadest interpretation, the business of a geological survey has to do with the natural resources of the state rather than with the final conversion and utilization of those resources. If it publishes a treatise on the uses of concrete because concrete is made of cement and stone and sand, why should it not publish treatises on the manufacture of steel, or the operation of a glass factory, or a pottery kiln or the use of stone-carving machines?

The provision of the Ohio law as to the duties of the State Geologist above quoted, makes it his duty to *study* the modes of occurrence and distribution of the useful minerals and the products of these (mineral) formations. We have italicized the word study. We take it that this word, as here used, is synonymous with *investigate*, that it implies original research into the minerals and mineral products of the State of Ohio. We do not see how the word can be stretched into meaning to study "the whole history of the subject scattered through the pages of the technical press." Nor do we see how the word study can mean to study and publish "the whole history of the subject, etc." If the word study can be construed to give a geological survey license to compile and print all scientific information to be found in the technical press on the subject of minerals and mineral products, where might not the "study" lead? Is it the function of any geological survey to rehash or even digest such published matter?

It is true we did commend the work of coal testing done at St. Louis under the supervision of the United States Geological Survey, because there we found *original investigation*, the kind of study that we believe the Ohio law should be construed to include. We did not find a summary of "the whole history of the subject" of fuel and its uses; but we did find an attempt to demonstrate the relative value of fuels by actual tests.

Our correspondent says that

> in the broad way, the geology of Ohio is now known. What is done hereafter in this line will be of interest chiefly to the student of pure science—the professional geologist.

We were under the impression that some of the State still remained topographically unmapped. We also believed that bore holes had as yet not made a sieve of its acres; and that there was still some doubt as to the location of all the oil and coal and stone and fire clay deposits within its borders. The *broad* facts about its geology may be known, but it is not probable that the *detailed* facts as to resources will be known for many generations yet to come. It is well to know the broad fact that the coal measures cover certain large areas of Ohio, but is it only a matter of interest to "students of pure science" to know where each coal bed lies?

We have no desire to see the work of the Geological Surveys confined to measuring dips and strikes and classifying fossils; but we should like to see their work proceed in logical order. The skeleton upon which the flesh of geological facts must be placed is the topographic survey. That skeleton has so many bones missing in Ohio that we believe it is entitled to a little geological attention before the education of the public on the subject of the uses of concrete is begun.

The appropriations for the work are meager? So much the stronger is the argument in favor of doing that which private individuals are not doing and will not do.—Ed.)

AN EXPERT REPORT ON THE COLLAPSE OF BUILDINGS IN NEW YORK CITY.

Following the collapse of a number of buildings in course of erection in the upper part of New York City (March 19 and 20, 1905) a month ago, President John F. Ahearn of the Borough of Manhattan appointed a Board of Experts to investigate and report upon the causes of the failures and the responsibility therefor. The Board was made up of Messrs. Thos. J. Brady, formerly Superintendent of the New York Building Department, Otto M. Eidlitz, M. Am. Soc. C. E., a prominent building contractor, and Geo. A. Just, M. Am. Soc. C. E., a member of the Commission which drafted the present New York Building Law.

This board has just submitted its report to President Ahearn. It gives its views as to the direct and indirect causes that operated in producing the collapses, and concludes with certain recommendations for improved methods of conducting building work in New York City.

As may be remembered from our note of the accidents in question, the buildings affected were ordinary "flat" buildings, or tenement houses, five to six stories high in the various cases. In most of the cases an entire row of flats was involved, of which one or more failed. The various cases examined were by no means situated close to-

gether, as may be seen from the following statement of their location:

Southwest corner of First Avenue and One Hundred and Seventh Street; three buildings.
Northwest corner of Eighty-eighth Street and Lexington Avenue; one building.
South side of One Hundred and Forty-fourth Street, 175 feet east of Seventh Avenue; five buildings.
North side of One Hundred and Thirty-sixth Street, 410 feet west of Fifth Avenue; two buildings.
South side of One Hundred and Fortieth Street, 110 feet east of Lenox Avenue; one building.

The extent of the collapse in the different cases varied, from the fall of a single section of wall 20 ft. or less in width, to the collapse virtually of one or more complete tenement buildings. At the time the accidents occurred it was believed generally that the failures originated in the walls themselves, being caused by buckling of the walls from failure of the mortar joints. As the day preceding the general series of failures was exceptionally warm, the temperature rising above 70° F. in the middle of the day, it was considered that the thawing-out of frozen mortar which had been laid in freezing weather and had never set, was the prime cause of failure. The report of the Board of Experts gives a different opinion, and lays the blame upon the foundations:

"From our investigation we conclude that in every case the collapse, or the partial destruction, of these buildings was directly due to the failure of their foundation walls.

"We found these walls full of voids, built of irregular and undersized stone, improperly bonded, and imperfectly bedded. The mortar used was of an inferior quality and improperly mixed. Both the materials and workmanship were in flagrant violation of Section 26 of the Building Code.

"Although the sudden change in temperature which occurred on the night of the 18th of March may have contributed to the failure of the stone foundation walls in these various buildings, it is nevertheless a fact that these walls were of such inferior workmanship and materials as to make them insufficient to sustain with safety, at any time, the superimposed loads.

"Our inspection revealed many violations of the Building Code, which, while not contributory to the destruction of the buildings, were in themselves a distinct menace to their permanency, inasmuch as they eliminated or reduced the factors of safety which the code provides.

"Our comparison of the approved plans with the buildings showed that the corrections and amendments required by the Bureau of Buildings, as a prerequisite for the issuing of the permits, were generally disregarded in construction, although consented to in writing by the applicants in their desire to secure such permits. The work of the engineering staff of the Bureau of Buildings was therefore completely nullified.

"The applications relating to the above mentioned buildings showed that in only one case was the architect of record to superintend the construction. In no case was the name of the builder stated. These omissions left in question the competency of those who were to supervise and the character of the contractors who might be selected to erect the buildings.

"We can therefore only conclude that these buildings were erected without proper supervision, under inefficient inspection, and by incompetent contractors; that the provisions of the Building Code were generally disregarded, and that a very low standard of work is typical in this class of buildings.

"In further compliance with your request, and in view of these facts, we submit for your earnest consideration the following recommendations:

1. Architects should be required by law to supervise the construction of buildings for which they furnish plans.
2. A person before being allowed to practice as an architect should hold a diploma from some institution of learning, or from a recognized board to be created hereafter. The personnel of this board and the methods of its operation should be left to a commission composed of representatives of the various architectural associations and members prominent in that profession.
3. A register of those authorized to practice architecture should, be kept by the Bureau of Buildings, and permits for the erection or alteration of buildings

Theodore Perry Shonts, Chairman.

Brigadier-General Oswald H. Ernst.

Rear-Admiral Mordecai T. Endicott.

North side of One Hundred and Thirty-fifth Street 110 feet east of Lenox Avenue; eight buildings.
North side of One Hundred and Forty-third Street, 425 feet west of Lenox Avenue; two buildings.
North side of One Hundred and Third Street 150 feet west of Second Avenue; one building.

This includes only those cases located in the Borough of Manhattan; at least one other case occurred in the Borough of the Bronx, northeast and across the Harlem River from the territory in which the above cases lie.

John Findlay Wallace, Chief Engineer.

Charles E. Magoon, Governor of Canal Zone.

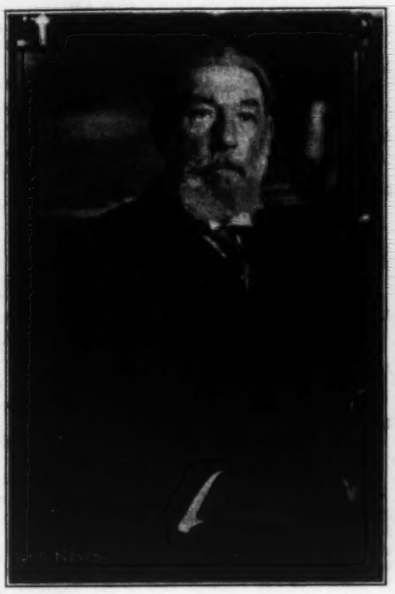
should be issued by the Superintendent of Buildings only to those so registered.

4. All contractors for mason work or structural steel work should be licensed. The cooperation of the recognized organizations in these trades should be sought in the establishment of such board or bureau.

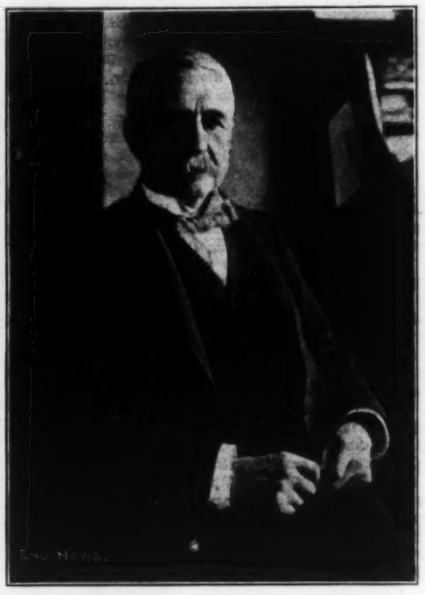
5. It shall be unlawful to permit the building of mason work or the erection of structural iron work by persons not so licensed.

"The substance of these recommendations, enacted into law, would make the recurrence of similar accidents practically impossible, as such enactments would secure competent architectural supervision and capable contractors for all classes of building operations. The rigid, conscientious inspection of works in progress, which the Bureau of Buildings has failed to secure in these cases, is then a matter of secondary importance."

It may be remarked here that, in the present organization of the City of New York, the supervision of building construction is a function of the Borough, not of the City. Consequently, each of the five boroughs of the city maintains a Bureau of Buildings, under the control of the Borough President. All these five Bureaus are governed by the Building Code, which forms part of the city's charter; but additional regulations may be made by the Bureau for its territory. The report above presented relates to that Borough—the old City of New York—in which building construction is largest in amount and therefore most largely in need of supervision.



Benjamin M. Harrod.



Brigadier-General Peter C. Hains.

THE MEMBERS OF THE NEW PANAMA CANAL COMMISSION.

We present herewith portraits of the several members of the new Panama Canal Commission, whose appointment was announced last week. Brief biographies of each of the new Commissioners were printed on page 372 of our last issue. We may note here that five of the seven Commissioners are well-known engineers; that two of the five, Messrs. Ernst and Hains, represent the Army Corps of Engineers, while Admiral Endicott represents the Navy, leaving Messrs. Wallace and Harrod (both of whom are Past Presidents of the American Society of Civil Engineers) as the civilian engineers of the Board.

NOTES FROM THE ENGINEERING SCHOOLS.

STEVENS INSTITUTE OF TECHNOLOGY.—The authorities of the Institute have taken up vigorously the task of raising the additional $100,000 required to render available the $100,000 conditionally donated by Mr. Andrew Carnegie and President Humphreys ($50,000 each) at a recent dinner of the "Stevens" alumni. Through the generous good will of the Stevens family, the Institute has been enabled to secure for athletic grounds, campus and building purposes that part of the historic "Castle Point" estate at Hoboken most advantageous for such uses. In the near future, this land will be graded and properly laid out, if the hopes of the Institute management are realized. A portion of this ground is now being excavated to serve as the site for the Morton Memorial Laboratory of Chemistry. The erection of this building will be pushed forward rapidly and the faculty hope that at the beginning of the next school year it will be at least partially available for the instruction in chemistry. As the name indicates, it is to be a memorial to Dr. Henry Morton, the late president of Stevens Institute.

STATE COLLEGE OF WASHINGTON.—The name of this institution has recently been changed from "Washington Agricultural College and School of Science" to that given above, by the state legislature. This change, it is hoped, will greatly enlarge the opportunity for instruction along engineering lines. The total enrollment for this year will approximate 800 students. This institution is now 13 years old and its growth has been phenomenal. The recent legislature appropriated $160,000 as the state maintenance fund for the next two years. This, including the government fund, will make in all about $275,000 available for the use of the college for the next two years. More than half of the present Freshman class are enrolled in Mechanical, Electrical, Civil, or Mining engineering.

THE PRODUCTION OF HYDRAULIC CEMENT in the United States during the year 1904 is reported in a statement recently issued by the U. S. Geological Survey. The total production of Portland, natural-rock, and slag or Puzzolan cements in 1904 was 31,675,257 barrels, valued at $26,031,920. The production for 1903 amounted to 29,899,140 barrels of hydraulic cement, valued at $31,931,341. In the production of 1904 there is a gain of 1,776,117 barrels over that for 1903, but in the value of the cement produced there is a loss of $5,899,421. Of the total amount of cement manufactured in the United States in 1904, 26,505,881 barrels were Portland cement, valued at $23,355,119; 4,866,331 barrels were natural-rock cement, worth $2,450,150, and 305,045 barrels were slag or Puzzolan cement, with a value of $226,651.

A SANITARY CENSUS OF NEW YORK CITY has been begun by the local health department. An appropriation of $35,000 is available and it is hoped that more will be added so the boroughs of Queens and Richmond may be covered. The work is to be done by physicians and will cover population, certain vital statistics and sanitary conditions.

A VIOLENT EARTHQUAKE affected the northern part of India on April 6, 1905. The City of Lahore, in the Punjab, and the region northeast of that city, suffered a series of violent shocks of unusual duration. Numerous cities were completely wrecked, and probably thousands of persons killed.

A RESERVOIR FAILURE at or near Madrid, Spain, on April 8 caused the death of a large number of workmen and the injury of many more. From the rather indefinite press dispatches it appears that a large covered reservoir was under construction when some of the columns, or else the foundations on which they stood, gave way, burying the workmen in the ruins. One report states that a portion of the reservoir rested on some underground vaulting which gave way. It is also stated that a few columns and arches collapsed several weeks ago.

THE LAKE VERA DAM of the Bay Counties Power Co., located about three miles from Nevada City, Cal., failed on April 2. It is reported that it was a crib dam, 50 ft. high and 100 ft. long, and that the water stood at the level of the top when the break occurred.

RAILROAD TRAIN ACCIDENTS for the quarter ending Dec. 31, 1904, show a gratifying decrease in casualties to passengers from the heavy record of the previous quarter. Of the 53 passengers killed during the quarter, 29 were killed in one collision, where a freight train, which had been ordered to wait on a siding till an east bound passenger train and all its sections had passed, moved on to the main line after the first section had gone by.

Two derailments of the month occurred at derailing switches. In one, the towerman pulled open the switch immediately in front of an approaching train. He had been stationed at this point only three days and mistook the track on which the train was running. In the other the engineer and fireman on the locomotive were both asleep. One derailment, in which 45 persons were injured, was caused by a broken rail.

The total train accidents for the quarter were 1,760 collisions and 1,190 derailments, causing damage to cars, engines and track of $2,406,081, and resulting in the death of 225 persons and the injury of 2,914. The total number of railway casualties of every sort for the quarter, including those sustained by employees at work and passengers in getting on or off trains was 14,027 injured and 951 killed.

THE AWARD OF MEDALS OF HONOR to persons, "who shall hereafter, by extreme danger, endanger their own lives in saving, or endeavoring to save, lives from any wreck, disaster, or grave accident, or in preventing or endeavoring to prevent such accident," was provided for by an act of the last Congress, and a circular stating the conditions of application for such medals has just been issued by the Interstate Commerce Commission, which is to receive applications.

According to the circular, all applications for such medals must be accompanied by sworn affidavits as to the circumstances of the alleged act of heroism. Applications are to be first passed upon by a committee of five persons, consisting of the secretary of the commission, the chief inspector of safety appliances, two inspectors of safety appliances designated by the commission, and the clerk of the safety-appliance examining board, who will act as clerk of the committee. This committee reports through the commission to the President.

LOCAL RAILWAY SERVICE in competition with parallel electric railways is to be tried by the Chicago & Alton Ry. Two sections of line have been selected for the experiment; between Bloomington and Pontiac, Ill., 36 miles (double track), and between Springfield and Girard, Ill., 25 miles (single track). Trains will be run every hour and will stop at road crossings. If this service proves successful it will be established on other sections, as the railway now has close competition with electric interurban lines on numerous parts of its line, and its local traffic has suffered severely in consequence. Mileage books at a rate of 2 cts. per mile will be issued, and it is stated that very much quicker time will be made than on the electric lines. The lighter locomotives will be used for this service, and cars seating 80 passengers each; each train will have only one or two cars.

PERSONAL.

Mr. Frank O. Sinclair, M. Am. Soc. C. E., has been re-elected City Engineer of Burlington, Vt.

Mr. R. G. Hengst has been appointed Assistant Chief Engineer of the Western Allegheny R. R., with office at New Castle, Pa.

Mr. J. W. Stearns has been appointed Assistant City Engineer of Indianapolis, Ind., in charge of railroad track elevation work.

Mr. George W. Lilly, M. Am. Soc. C. E., has resigned his position as Assistant Engineer of the Department of Public Service of Columbus, O.

Mr. T. T. Lyman has been appointed General Sales Manager of the H. W. Johns-Manville Co., 100 William St., New York, manufacturers of asbestos materials.

Mr. A. W. Munster, heretofore acting Chief Engineer of the Chicago Great Western Ry., has been appointed Chief Engineer, with headquarters at St. Paul, Minn.

Mr. A. P. Morris, a draftsman in the U. S. Reclamation Service has been transferred from the Washington Office, and will report at Belle Fourche, S. Dak., for duty, May 1.

Mr. Ernest Adam has resigned his position as City Engineer of Newark, N. J., owing to ill health. He had been connected with the engineering department of the city for 39 years.

Mr. E. N. Layfield has been appointed Chief Engineer of Chicago Terminal Transfer R. R. Co., vice Mr. F. E. Paradis, who has resigned to engage in the private practice of his profession.

Mr. Ferdinand McCann, M. Am. Inst. Min. Engrs., of the City of Mexico, has been appointed General Manager of the Los Grandos Mining Co., and the Guerrero Mining & Exploration Co.

Mr. Chas. S. Slonmaker, who was transferred from the U. S. Weather Bureau to the Reclamation Service in 1903,

has been assigned to work as observer under the direction of P. M. Churchill, North Dakota.

Mr. S. E. Smith has resigned his position as Chief Engineer of the Donora Works of the Carnegie Steel Co., at Donora, Pa., and has been appointed Chief Engineer of the Passaic Steel Co., of Paterson, N. J.

Mr. E. M. Grime, until recently Assistant Engineer for the Chicago Great Western Ry., at St. Paul, Minn., has been promoted to the position of Division Engineer of the Ft. Dodge Division, with headquarters at Clarion, Ia.

Mr. Jacob J. Haarer has been appointed Commissioner of Public Works of Detroit, Mich., and Mr. Theodore H. Hinchman, Jr., of the engineering firm of Field, Hinchman & Smith, has been appointed Lighting Commissioner.

Mr. H. S. Balliett has been appointed Engineer of Maintenance of Way of the Grand Central Station and Harlem Line of New York Central & Hudson River R. R., with headquarters in the Grand Central Station, New York City.

Mr. Fred S. Darling, Division Engineer of Construction of the Canadian Pacific Ry., at Montreal, Que., has been transferred to Toronto, Ont., where he will have charge of the construction of the branch line from Toronto to Sudbury.

Mr. John C. Trautwine, Jr., of Philadelphia, who has been Secretary of the Association of Engineering Societies since January, 1894, has resigned the office. He will be succeeded on May 1 by Mr. Frederick Brooks, of 31 Milk St., Boston.

Mr. A. H. Cuthbert, of Elmira, N. Y., has been appointed Assistant Engineer of the Monongahela Division of the Pennsylvania R. R., to succeed Mr. J. H. Gumbes, who has accepted a position with the West Jersey & Sea Shore R. R.

Mr. Arthur S. Ives, for some years in charge of the Centrifugal Pump Department, of R. D. Wood & Co., of Philadelphia, resigned March 1st, to become Assistant General Manager of the Glamorgan Pipe & Foundry Co., Lynchburg, Va.

Mr. Geo. D. Evans has resigned his position as Superintendent and Engineer in Charge of the Philadelphia and Reading Coal & Iron Co.'s strippings, at Turkey Run, Pa., and will go to Charleston, W. Va., to engage in mining engineering.

Mr. Richard Devens, for some years connected with the European Office of The Brown Hoisting Machinery Co., of Cleveland, has been appointed Manager of the New York Office, 26 Cortlandt St., to succeed Mr. W. A. Stadelman, who has resigned.

Mr. John W. Boardman, Jr., who has been connected with the operating and general sales department of the Southern States Portland Cement Co., with headquarters at Atlanta, Ga., is now actively connected with the Cement Machinery Co., of Jackson, Mich.

Mr. A. N. Johnson, Assoc. M. Am. Soc. C. E., Chief Engineer of the Division of Highways of the Maryland Geological Survey, has resigned his position to accept that of Highway Engineer of the U. S. Office of Public Roads. Mr. Johnson's new duties will begin about the first of May.

Mr. E. H. Keating, formerly Manager of the Toronto Ry. Co., of Toronto, Ont., has been appointed Manager and Engineer for a system of electric railways in and around the city of Monterey, Mexico, the franchises for which have been secured by the Mackenzie & Mann Syndicate of Toronto.

Mr. Roger C. Smith, for the past six years connected with prominent electrical and consulting engineering firms, has opened an office at 44 Van Nostrand Ave., Jersey City, N. J., and will engage in a consulting engineering practice in electric lighting and heating installations for buildings, residences, etc.

Mr. A. I. Stiles has resigned as Engineering Aid, U. S. Reclamation Service, to accept a position under the Peruvian Government. Mr. Stiles attended the Leland Stanford University, California, and has been connected with the Coast and Geodetic Survey, making two trips to Alaska. He also has been connected with the Examiner of Surveys, General Land Office.

Mr. A. L. Hartridge, formerly Chief Engineer of the Union Depot, Bridge & Terminal Co., of Kansas City, Mo., and Consulting Engineer for the Kansas City, Ottawa & Burlington R. R., has gone to Guatemala, Central America, to superintend the erection of bridges on the Guatemala Northern R. R. Mr. Hartridge probably will be gone two years. His headquarters will be at Puerto Barrios.

Mr. F. W. Huber, Assistant Engineer, U. S. Reclamation Service, now at Berkeley, Cal., will be transferred to L. H. Taylor, Hazen, Nev., to carry on tests of cement. Mr. Huber was born in Virginia and attended the Baltimore City College and Cornell University. He was engaged in various engineering capacities by the United Railways of Baltimore and the Baltimore & Ohio Railroad Co., up to May, 1903, when he received an appointment as Engineering Aid in the Reclamation Service.

Mr. H. C. Hurd has resigned his position as Assistant Engineer in the U. S. Reclamation Service, to accept a position under the Peruvian Government. Mr. Hurd was graduated from Princeton University. He spent some time on the construction of the Broadway Cable road, New York City. He was subsequently engaged with the Nicaragua Canal Commission, the Isthmian Canal Commission, Washington & Annapolis Electric Ry. Co., and as special agent of the State Department on work on Nicaragua Canal Route.

Mr. E. H. Baldwin, Assoc. M. Am. Soc. C. E., has been appointed Constructing Engineer in the U. S Reclamation Service. He is to report to Mr. C. E. Wells, at Casper, Wyo., for duty on the Pathfinder Reservoir. Mr. Baldwin is a graduate of Cornell University. In 1892 he was Engineer and Superintendent of Grading New Streets in Seattle, Wash. Since that time he has been with the Omaha Canal & Power Co., Omaha, Neb.; the Fall River Water Works Co., Fall River, Mass.; the City Engineer's Office, Newton, Mass.; Sewer Division, Street Department, Boston, Mass., and from November 1895 to date with the Metropolitan Water and Sewer Board of Boston, Mass.

Mr. H. T. Patterson, Assoc. M. Am. Soc. C. E., Assistant Engineer, U. S. Reclamation Service is to be transferred from Hazen, Nev., to Roswell, N. Mex., to succeed Mr. H. C. Hard, whose resignation from the Reclamation Service is mentioned elsewhere in these columns. Mr. Patterson attended Rose Polytechnic Institute, Terre Haute, Ind., and afterwards had a course of special work at the Missouri School of Mines. He has been engaged on ditch construction for the Taylor-Park Gold Mining Co., as Assistant City Engineer of Colorado Springs, Colo., with the Colorado Springs Rapid Transit Co., and with the Denver & Rio Grande Ry. He entered the employ of the Reclamation Service in 1902.

Mr. Carl Ewald Grunsky, M. Am. Soc. C. E., who was recently appointed consulting engineer and advisor to the Director of the U. S. Geological Survey, is a Californian by birth, although his professional education was acquired at the Real-schule and the Polytechnic Institute, Stuttgart, Wurtemberg, Germany. His first professional employment was as topographer with a river surveying party of the State Engineering Department of California in 1878. The next year he was made Assistant State Engineer in Charge of computations and office work relating to stream gaging, and in 1882 he was advanced to the position of Chief Assistant, continuing as such till 1887. From this latter date until 1899 he was in private practice at Sacramento and in San Francisco, also serving during 1889 and 1890 as a member of the Examining Commission on Rivers and Harbors for California. In 1892-93 he was one of the engineers selected to design a sewer system for San Francisco and served on the Sewerage Board of that city. In 1893-94 he again served the State of California as a consulting engineer to the Commissioner of Public Works, dealing with drainage and river rectification problems. In January, 1900, he was appointed City Engineer of San Francisco, which position he held until appointed Isthmian Canal Commissioner. He has contributed several water supply papers to the U. S. Geological Survey's publications, and in 1899 and 1900 he was one of the experts reporting to the U. S. Agricultural Department upon irrigation and use of water from rivers in California.

Obituary.

James H. Love, President of the Hudson County Park Commission, New Jersey, died April 5, at his home in Jersey City, N. J.

C. C. Warren, President and Treasurer of the Warren Electric & Manufacturing Co., of Sandusky, O., died March 22, aged 70 years.

John Olmsted, for the past 29 years President of the Springfield Street Railway Co., of Springfield, Mass., died last week, at his home in that city, aged 84 years.

George B. Shepley, President and Treasurer of Shepley & Co., contracting engineers, of Worcester, Mass., died suddenly April 3, in that city. He was born in St. Cloud, Minn., in 1860.

William S. DeCamp, M. Am. Inst. Min. Engrs., died April 5, of pneumonia, at his home, Mount Morris Park, New York. He was interested in mines in Morris County, New Jersey, and in lumber lands in Herkimer County, New York. He was 59 years old.

Lawrence Van Wyck, for a long time connected with Market National Bank, of New York, died April 3, at his home in Brooklyn, N. Y. As a civil engineer he assisted in building the Hudson River R. R., and Erie Canal, and also the fortifications on Lake Ontario. He was born in 1825.

Mark Hubbard, a civil engineer, engaged in making surveys for a railroad in Virginia, died at Stonega, Va., March 29, from a wound sustained by the accidental discharge of a revolver. Mr. Hubbard was at one time engaged on the engineering work at the Market St. Subway, Philadelphia.

George M. Clarke, Traffic Manager for the Arabole Mfg. Co., of New York, died April 1, in that city. Mr. Clarke for many years was Superintendent of the Moshassuck Valley R. R. He had been also Superintendent of the Asheville & Craggy Mountain R. R. His home was in Central Falls, R. I.

William B. Turner, formerly General Superintendent of the Edison Company's plant at Schenectady, N. Y. (now the General Electric Co.) died of heart failure March 2 at Hot Springs, Ark. Mr. Turner severed his connection with the Edison Company in 1892, when the business was purchased by the General Electric Co. In 1894 he went to Chicago, where he was for a few years connected with the Chicago Edison Co.

Charles S. Tilton, formerly County Surveyor of San Francisco County and City Engineer of San Francisco, died March 31, in that city, aged 59. He was five times elected City and County Surveyor, taking office the first time in 1885, and serving two years. He was elected again in 1891, serving two years more. In 1895 he became a candidate again for the third time and was continued in office until 1901, when the position became an appointive one.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN ELECTROCHEMICAL SOCIETY.
April 25 to 27. Annual meeting at Boston and Cambridge, Mass. Secy., S. S. Sadtler, 39 South 10th St., Philadelphia, Pa.

NATIONAL MUNICIPAL LEAGUE.
April 25 to 28. Annual convention at New York, N. Y. Secy., C. R. Woodruff, Philadelphia, Pa.

INTERNATIONAL RAILWAY CONGRESS.
May 3 to 15, 1905, at Washington, D. C. Secy. of American Committee, W. F. Allen, 24 Park Place, New York.

AMERICAN WATER-WORKS ASSOCIATION.
May 8 to 12, 1905. Annual meeting at West Baden, Ind. Secy., J. M. Diven, Charleston, S. C.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
May 16, 1905. Annual meeting at New York, N. Y.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 6, 7, 8, 9, 1905. Annual spring convention, at Scranton, Pa. Secy., F. R. Hutton, 12 West 31st St., New York, N. Y.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 6 to 9, 1905. Annual convention in New York. Secy., Richard Moldenke, Watchung, N. J.

{MASTER CAR BUILDERS' ASSOCIATION.
{AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 14-21, 1905. Annual meeting at Manhattan Beach, N. Y. Secy., J. W. Taylor, The Rookery, Chicago, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 19 to 23, 1905. Annual convention at Asheville, N. C. Secy., R. W. Pope, 95 Liberty St., New York, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 20 to 23. Annual convention at Cleveland, Ohio. Secy., Charles Warren Hunt, 220 West 57th St., New York, N. Y.

LEAGUE OF AMERICAN MUNICIPALITIES.
August 23 to 25. Annual meeting at Toledo, O. Secy., J. McVicar, Des Moines, Ia.

ENGINEERS' CLUB OF CINCINNATI.—A regular meeting of the club will be held on Thursday evening, April 20, at the rooms of the Literary Club, 25 E. 8th St., Cincinnati, O. Messrs. E. J. Carpenter and J. N. Caldwell will present a paper on "Some Difficulties Encountered in Navigating the Ohio River and the Remedies to be Applied," which will be illustrated with lantern views. Secy., C. H. Meeds.

HONOLULU ENGINEERING ASSOCIATION.—The annual meeting of the association was held on March 20, 1905, at Honolulu, H. I. Officers were elected for the coming year as follows: Chairman, Mr. A. Gartley; Vice-Chairman, Mr. J. H. Howland; Secretary, Mr. E. G. Keen; Treasurer, Mr. J. H. Peters; Directors, Messrs. E. Kopke, R. J. Pratt and G. R. Ewart. After the business proceedings, the meeting continued in the form of a smoker, with musical entertainment and addresses.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—A meeting of the National Conference on Standard Electrical Rules will be held at 10 a. m., April 21, at 55 Kilby St., Boston, Mass. The American Institute of Electrical Engineers will be represented by a delegate, who will present any suggestions for amendments that may be found advisable by the Institute's Code Committee. Prof. A. E. Kennelly, Cambridge, Mass., is chairman of this committee, and any criticisms of the rules or suggestions for improvements should be addressed to him.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the regular meeting of April 5, 1905, at the society's house, 220 W. 57th St., New York, a paper entitled "A New Swing Bridge at Copenhagen, Denmark," by Mr. H. C. V. Möller, was read by the secretary. The bridge described is a railway bridge which is fitted with a hydraulic plunger center pivot, by which the whole bridge is lifted off its end supports when it is to be turned. Two hydraulic pressures are used, separate accumulators being provided, each in duplicate. The bridge is raised off its end supports by the high pressure, and when lowered it discharges, during the first part of its motion, into the low pressure accumulator; in the last part of its lowering the water is run into an open tank, so that the full end reactions are developed. A discussion of the paper was presented by Mr. J. C. Moses, who asked for more complete details of the hydraulic pivot arrangement. In further discussion the absence of information on the means used to steady the bridge horizontally was pointed out.